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J. C. Branner

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ERRATUM.

Vol. XXVI, p. 306, in the title to Dr. Hayes's article, dele "with a map."

ADDENDUM.

To bottom of page 248, after "Delphi Slate" add "or Black Lingula shale, equivalent of the Genesee Slate or Marcellus shale of New York."

THE

AMERICAN

JOURNAL OF SCIENCE AND ARTS.

[SECOND SERIES.]

ART. I.—*Some Principles of Animal Psychology*; by D. F. WEINLAND.

Read before the American Association, at the Baltimore Meeting, May, 1858.

THE true difference between plants and animals consists in this, that animals have a consciousness of an outer world, while plants have none.

We are accustomed to distinguish animals from plants by their being endowed with free, that is, voluntary locomotion, and with feeling. Linnæus long since said: Saxa crescunt, Vegetabilia crescunt et vivunt, Animalia crescunt vivunt et sentiunt. A certain kind of feeling however cannot be denied to some plants, for instance to the Mimosa. As to the "voluntary" motion, which modern handbooks generally consider as the standard difference between plants and animals, I shall try to show that the term voluntary is far better replaced by the term "conscious of an outer world." What is it that strikes the microscopist as vegetable-nature in the Navicula, and as animal-nature in the Monas? Both move, but the Navicula in its steady onward course runs foul of every obstacle that crosses its way, while the Monas dodging with ease and dexterity, finds its winding way through a host of obstacles, apparently without touching one. It is this evident consciousness of surrounding objects that characterizes the animal.

The consciousness of an outer world is the fundamental principle of the soul of animals. The consciousness of self, of the Ego,

which is rather obscure, even in the highest animals, as it is also in the human child, is proportionate to the consciousness of an outer world; it is a result of the latter, for it is only in opposition to an outer world, that the animal conceives itself and becomes conscious of itself. The degree of psychical development in different kinds of animals may be judged from the degree of development of the consciousness of an outer world. The soul of an animal is the higher, the more relations it has to the outer world, that is, the larger the horizon of its outer world. The latter point I will explain with some illustrations taken from the lower animals, in which the psychical life is more simple, and therefore easier to understand.

What is the outer world of a coral-polyp? With hundreds of its kind it lives on the same coral-stock; it is there fixed and is able to move its mouth and tentacles only; thus it awaits its prey, a little craw-fish, without eyes, and without touching it—by a sense unknown to us—it perceives the presence of its prey, throws out its lasso-cells and catches it. Every individual has both the sexes united. Though closely crowded together, I never could notice a trace of psychical relation between the polyps of the same stock. What is the outer world of such a polyp? The whole range of its psychical life is evidently confined to the objects of food.

Let us now rise one step higher, to a Helminth, an Ascaris, that inhabits the intestine of some vertebrate. In regard to feeding it stands evidently on the same, perhaps on a lower level than the polyp, but still we must rank it psychically higher! The sexes are divided, and in the line of reproduction the male and the female individuals meet each other. There is therefore besides a consciousness of an outer world in regard to food, evidently also, a consciousness of other living individuals, although that consciousness may be dark enough.

We may take a bee, a wasp, or any of the social Hymenoptera, as a third step. In the bee the consciousness of the existence and the interest in other living individuals is not confined merely to the season and to the instinct of reproduction, but to the whole life. At any time the individuals of the bee-hive know each other, give each other signs, help each other, fight for each other. It is evident how much more varied the relations to the outer world, how much more extensive the latter is for a bee than for an Ascaris, and still more than for a polyp.

In order to judge how extensive the outer world is, of which an animal is conscious, that is, in order to judge about its psychical horizon, we must investigate the organs of that consciousness, that is, the psychical organs of animals.

The psychical organs of animals are of three kinds: (1.) RECEPTIVE *organs, organs which receive impressions from the outer*

world; here belongs the whole skin-system including the senses. (2.) Reflective *organs, that is, organs which combine the impressions received by the receptive organs; here belongs the central nervous system.* (3.) Reactive *organs, that is, organs which react upon the outer world; they are the servants of the central nervous system, which go from within outward, while the receptive organs go from without inward. These reactive organs consist in the whole system of voluntary muscles, with the bones which belong to them.*

The student of animal psychology has mainly to depend upon the third kind of organs, namely, the reactive, not only because the functions of the receptive and reflective organs are more or less hidden, but also because their functions are in fact the mirror of the whole psychical life of the animal, being also the resultants of the functions of the receptive and reflective organs.

The functions of the reactive organs are the voluntary motions. When observing these motions in an animal more closely, we soon perceive two kinds of motions, which are in their ends entirely different.

Let us look at a dog. We see in the first place, that it makes many motions, which have no other purpose than to satisfy the Ego of the dog itself. Such are the motions by which it eats, drinks, etc. These motions we call subjective, as having reference exclusively to the Ego, to the subject of the dog itself. But besides these, we see other motions in the dog, which have no immediate reference to the Ego of the dog, but to other dogs, or to men; we see motions of the head, the eyelids, the tail, of the whole body, by which the dog would show to other dogs or to his master, what it thinks, feels or wants. This second kind of motions I propose to call sympathetic motions.

The subjective motions are common to all animals and must be so. We have seen them in the polyp, and we see them in man. They are, generally speaking, the same throughout the animal kingdom. But the greatest diversity exists in regard to the sympathetic motions with different animals, and it will be evident from the following illustration, that the degree of their development is the principal standard for the student of animal psychology. The more the organs for sympathetic motions are developed, the more extensive is the outer world of which the animal is conscious, and the larger is its psychical horizon. Let us compare a fish, a lizard, a monkey and finally man in regard to the organs for sympathetic motions. The fish lying horizontally in the water, its head, neck, trunk and tail forming one continuous massy body; its eyes cold and stiff, turned sidewards, nearly immovable; no voice; hardly traces of an ear,—what organs has this animal to show to its fellow-creatures the processes of its soul? How different a spectacle offers a lizard to the thinking observer! Its body raised upon four legs; a dis-

tinct neck, upon which the head plays freely, thus giving at once to the eyes a horizon not only towards the sides but also upwards and downwards. And how expressive are those eyes! their expression mainly lies in the play of the eyelids, (of which the fish is destitute,) so that from the eyelids alone an experienced observer will perceive, whether the lizard is contented, or sad, or enraged. The tongue, which in the fish is a mere organ for swallowing food, is in the lizard a true organ of sympathetic motions, for we often can see them licking at each other in play or in love. The ear is well developed; they like music and some of them have a voice, as those well know who have spent a night in a virgin forest of the tropics. I will not dwell upon the intermediate degrees of psychical organization as exhibited in birds and the lower mammalia, but consider next the monkey. How rich at once the organization for sympathetic motions. The front legs—in the lizard mere locomotory organs—are in the monkey arms with which the mother embraces the young. The foot, a mere organ of support in the lizard, has become a hand, with which he grasps the hand of his mate. The lips, of which there is no trace in the lizard, are in the monkey very perfect organs of sympathetic motions. With the lips and the whole play of the muscles of the face, with the eyelids, with the tongue, with sounds, etc., the monkey shows to his fellow creatures what it likes and what it hates, what it wants and what it thinks.

Finally let us consider man. The natural position of the monkey is on four legs; in consequence, his head is naturally half bent downwards, thus confining the horizon of his eyes, and his front legs though used as arms are at the same time still organs of locomotion, mainly of climbing. On the contrary, man standing upright on his legs has his arms and hands free, they are perfect organs of sympathetic motions, locomotion being confined to the lower extremities. His head stands free upon the neck, thus giving to all the senses and particularly to the eyes the largest possible horizon. His eye is the mirror of his soul in which the fellow-man reads the innermost thoughts and feelings. His lips, tongue, and the whole apparatus of the larynx produce by their motion the most perfect of all sympathetic motions, language. These and many more not less interesting points are suggested by a comparison of the organs for sympathetic motions, and from the facts principles of practical importance for educational purposes may be derived; but what I have mentioned is sufficient illustration of the truth that owing to the great perfection of organs for sympathetic motions, the relations of man to his fellow beings are far the most diversified and at the same time the most intimate, not only to his fellow beings but to the outer world generally. Whatever our civilization has performed, has been done by improving these natural pyschical

organs. The outer world of the polyp is confined to the objects of its prey, the outer world of the civilized man is the Universe. Our steam vehicles on land and on sea, what else are they than improved organs of locomotion; our letters, our books, our journals, our telegraphs, what else are they than organs of human language on a more extended scale? our telescopes, our microscopes, what else are they than the receptive sense of the eye extended. Thus all the inventions of our civilization tend to enlarge the horizon of the individual man. And this is the true destiny of man. I do not know of a greater motto or life-principle than that which was written on the temple of the oracle of Delphi in ancient Greece: *Γνῶθι σεαυτόν*—"Know thyself;" but another is equally great, written by Wilhelm von Humboldt, the great philologist, (brother of the author of the Cosmos), it is this: "I wish to leave when dying as little as possible behind me in this world, with what I have not come in contact," that is what I have not mastered with my mind. Humboldt wanted the most perfect knowledge of the outer world, while the Greek philosopher wanted the deepest knowledge of himself. One of these sentiments is only the reverse of the other, or rather it follows immediately from the other. The most thorough knowledge of the outside world involves the deepest insight into ourselves; just as in morals, he who loves his neighbor the truest is the happiest, and thus loves himself the truest.

ART. II.—*On some unusual modes of Gestation;* by JEFFRIES WYMAN, M.D.

Communicated to the Boston Soc. of Natural History. (See Proceedings of the Society, Sept. 15, 1857.)

AMONG Batrachians the circumstances under which the young are developed, though less varied than in some of the other classes of vertebrates, still present a considerable range. By most species the eggs are deposited in the water either upon aquatic plants or on the bottoms; by others, as in *Salamandra erythronota*, they are laid in damp places under logs or stones; with some the evolution of the embryo commences a short time previous to the laying of the egg and is completed subsequently, while there are other species which are wholly viviparous.

The most remarkable deviations from the ordinary modes are to be found in those instances in which the eggs, after being laid, are again brought into a more or less intimate relation with the parent, as in the "Swamp toads" (*Pipa Americana*) of Guiana, where each ovum is developed in a sac by itself on the back of the female, in *Notodelphys* of Venezuela, where all the eggs are lodged in one large sac, also on the back, and is analogous to the

pouch of the Marsupials, and in *Alytes*, the "Obstetric toad" of Europe, where the eggs are wound in strings around the legs of the male who takes care of them until they hatch.

The species, the habits of which are noticed below, and which, in so far as I have been able to learn, have not attracted the attention of naturalists, adds another to the series just mentioned, though the relation of the fœtus to the parent becomes less intimate than in any of the preceding cases.

Hylodes lineatus (Dum. and Bib.) is very common in Dutch Guiana, and its peculiar habits are well known to the colonists. The first specimen with young which came to my notice had been preserved in alcohol, and was presented to me by Mr. G. O. Wacker, residing at Osembo, on the Para Creek, Surinam, and had been captured at some distance from the water. The young, ten or twelve in number, though separated from the parent, he assured me, when found, were attached to her back.

In the month of May, 1857, during an excursion to the country inhabited by the Bush negroes, above Sara Creek on the upper Surinam River, I had an opportunity for the first time of seeing these animals carrying their young. The grass and bushes were quite wet from a recent fall of rain, and this seemed the inducement that led them from their hiding places, for when the ground was dry none had been seen. They were very quick in their movements, and when alarmed went at once into the grass and thick bushes. One of my companions, Mr. John Green, and myself succeeded in capturing some specimens, which, as we were just leaving the village, were placed at once in alcohol. In one instance the larvæ were retained permanently adherent to the back of the parent, in consequence of the coagulation of the mucus covering the surface of the body, and are still preserved in the Museum of Comparative Anatomy at Cambridge. (Fig. 1.) The young, from twelve to twenty in number, were collected upon the back of the mother, their heads directed towards the middle line. They were about three-fourths of an inch in length. No limbs were developed, though in some of them the rudiments of a leg existed in the form of a small papilla on either side of the base of the tail. No especial organ was found to aid them in adhering to the back of the parent. The adhesion may have been effected by the mouth; this is rendered probable by the fact that all of them had the mouth in contact either with the skin of the parent or with that of another larva. A viscid mucus covering the integuments undoubtedly assisted in some measure to bring about the same results. However this may be, they retained their places perfectly well, and were not displaced when the mother, closely pursued, carried them through the grass.

On dissection of the young nothing was found materially different to conditions of the larvæ of other Anoura. The external

gills had disappeared, but were replaced by internal ones which were arranged as usual on three hyoid arches. The development of the lungs had commenced and these were represented by a slender conical mass of cells, but not permeable to air. The mouth was provided with finely denticulated horny jaws, and the intestinal canal was shorter and less spirally convoluted than in ordinary larvæ of frogs and toads. The stomach was not so much developed as to be distinguished from the rest of the intestine; but this last, after passing the liver, was somewhat dilated, and contained, as was shown by the microscope, large quantities of yolk cells which had not been absorbed and which were adherent to its walls.

We have here then a larva, in all of the details of its structure, especially in the existence of gills and of a flattened tail, adapted to aquatic locomotion and respiration, yet passing a portion of its time at least on the back of its parent and at a distance from the water.

I was not able to ascertain whether the eggs were primarily deposited in the water or not, but it is well known to some of the colonists that after the larvæ have reached a certain degree of development they are carried about in the manner just described and they do not know them under any other circumstances. The existence of yolk cells in the intestine, shows that for a period at least they may have from these a supply of nutriment. But after this is exhausted, and it appeared to be nearly so in those which I have dissected, how do they obtain their food? In the absence of limbs adapted to terrestrial locomotion can they leave the body of the parent? and if they cannot, do they, as in the case of Pipa and probably in Notodelphys, depend upon a secretion from her?

Among Fishes, as far as at present known, the external conditions under which the eggs are developed are more varied than in any other class of Vertebrates. There are scarce any known conditions of the higher classes to which there are not analogies at least in the class of fishes. Besides the ordinary mode of depositing eggs upon the bottoms, some of the Salmonidæ, like the turtles, bury their eggs, the Lampreys (*Petromyzon*), the Breams, (*Pomotis*), the Hassars (*Callicthys*), the Stickle-backs (*Gasterostei*), &c., build more or less complete nests. Among some of the Pipe fishes, (*Syngnathidæ*), the eggs and subsequently the young, are carried in a pouch analogous to that of the opossums and other marsupial animals, and among some of the Sharks there is a vitelline placenta analogous to the Allantoidian one of the Mammalia.*

* Prof. Owen (in Philos. Transactions, 1834,) has pointed out the vascular relations of the fœtal Kangaroo to the parent. The chorion is not vascular, but the umbilical vesicle is largely provided with blood vessels, and, as far as his investigations go,

Fig. 1.—Hylodes lineatus.

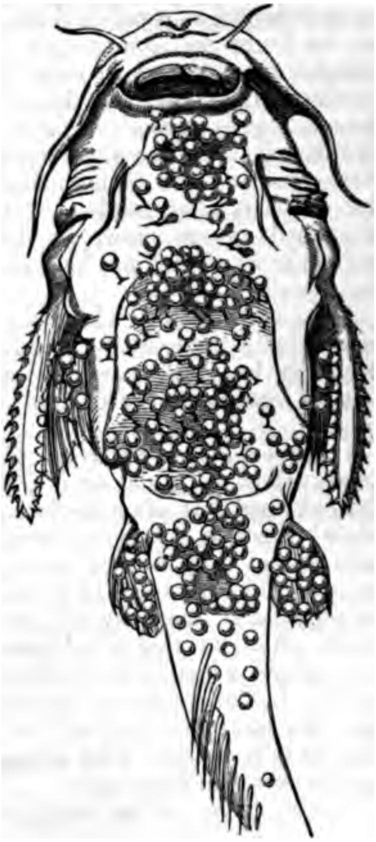


Fig. 2.—Aspredo lævis.

Fig. 4.—Pedicle showing capillary plexus, enlarged ten diameters.

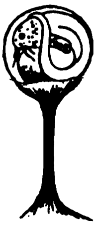


Fig. 3.—Pedicle with an egg attached, enlarged 4 diameters.

those species enumerated above where the eggs become or less intimately connected with the body of the parent they are laid may be added the Aspredos and some species agrus, from Guiana.

predo lævis (Cuv. and Val.), the "Trompetti" of the colonists, out fifteen inches in length, and belongs to a remarkable of Siluroid fishes, which, in addition to several peculiarities atomical structure, are remarkable for carrying the eggs and g attached to the under surface of the body. These fishes ery abundant in the waters of the Surinam where they are in the nets with other kinds. They are not used as articles od except by the negroes, who have a fancy for Siluroids ally, and in consequence these are known among the colo- as *Ningré fisi* or "nigger fish." A general account of the al structure of Aspredo, is given in the Hist. Nat. des ons, by Cuvier and Valenciennes, T. xv, p. 35.

describing the organs of reproduction, Valenciennes says: ovaries are small and contain very large eggs, which leads e belief that this fish is viviparous." In those specimens n I have dissected the eggs when mature are not remarkable eir very great size, being from 0·09 to 0·11 inch in diameter, after the commencement of the development of the fœtus, when the egg has already increased in size. The ovaries bout an inch and a half long and completely separated from other.

lenciennes further describes certain appendages to the under of the body: "A certain number of individuals in each es (of Aspredo) are remarkable for singular appendages on under side of the thorax and abdomen, and which, after the observations which I have been able to make appear to indi- a certain state of the female. I have not seen them in the s and the females do not have them at all times. They first ar as pores on the under and naked surface of the trunk; these enlarge and swell into tubercles, which subsequently gate into filaments, and the extremity of each filament is ed into a small cupule." *

It was in this state that Bloch saw them in an individual six cirrhi, and, taking them for specific characters, named ish *Platystacus cotylophorus*. But I have seen the same ap- ages in three species. Artedi, in the text of Seba, had

s the principal vascular surface by means of which an interchange takes place en the fœtus and the parent. The vitelline circulation then, as in sharks, is the atory circulation. The allantois of the Marsupials appears to remain in a entary condition, and does not form a connection with the parent. Thus the ar relation of the fœtus of some of the sharks, as Carcharias, with the parent itical with that of the Marsupials.

* uvier and Valenciennes, Hist. Nat. des Poissons. T. xv, p. 430.

already described two species, to which we now add a third. All three live in the waters of Guiana and this is all we know of their habits." *

From the preceding paragraphs it does not appear that Valenciennes had supposed that the so-called "cupules" were intended to contain or had contained ova, especially as he had previously expressed the belief that the Aspredos, in consequence of the large size of the eggs, were viviparous. The true use of the appendages in question relates to the development of the eggs, as the following description will show. The habits of the fish are well known to the fishermen, from one of whom Mr. Green obtained information with regard to their peculiar mode of gestation. After many ineffectual efforts, we at last succeeded in procuring the specimens on which the following observations were made, and Mr. Green has kindly presented to me some very fine ones from his own collection, without which this notice would have been much less complete. †

In the month of June the eggs are found adhering to the underside of the body, to the ventral and pectoral fins, and extend as far forward as the under lip, and as far backwards as the middle of the tail. (Fig. 2.) In some, however, the distribution is much more limited. I was unable to learn anything with regard to the transfer of the ova from the genital orifice to the point of their attachment. The only organ which seems in any way adapted to such a purpose is the slender and flexible tail terminated by a delicate caudal fin. It is possible that the eggs may be deposited on the bottom of the river, and subsequently attached by pressing the under side of the body upon them.

In those individuals where the ova were still in the ovary, but approaching maturity, the integuments of the under side of the body gave no other indications of the changes about to take place than of being quite vascular; the skin was perfectly smooth, no "pores" were visible, but a large vessel was seen emerging from the region of the liver, and descending along the median line gave off branches quite freely to the integuments. This may have some relation to the future development of the pedicles which support the eggs and perhaps to the nutrition of the embryo as will be adverted to hereafter.

In all the specimens which I have had an opportunity of examining, the eggs were either somewhat advanced or quite mature; so that no observations could be made on the earlier conditions of the egg and the formation of its pedicle. The pedicle is a flexible outgrowth from the common integuments, is about two lines in length, is attached to the skin by a slightly expanded base, and spreads out at its summit into a shallow cup

* Cuvier and Valenciennes, Hist. Nat. des Poissons. T. xv, p. 430.

† See an account of the habits of the Aspredo by Mr. Green in the Proceedings of the Boston Soc. of Nat. History for April, 1858.

cupule," for the support of the egg. It is composed almost rely of fibrous tissue, invested with a layer of tesselated helium. In some instances when the eggs were but little inced, numerous fusiform cells were detected among the s. It is vascular, two or three vessels reaching to the cup, re they ramify and form a somewhat extended capillary us. (Figs. 3 and 4).

he eggs vary according to the degree of development from)·09 to 0·15 of an inch in diameter, and are covered with an rnal homogeneous membrane, containing minute puncti- ı depressions—within this is a second, of a brownish color composed of epithelium. The embryos which were the ; advanced and just ready to hatch, had not as yet com- ely absorbed the yolk, and were coiled up within the mem- es, which in consequence of the irregularities of the mass ıed by the embryo, had no longer a spherical form.

he eggs are retained in connection with the cup apparently dhesion alone, for as soon as the fœtus escapes, the egg ıbranes become very easily detached from the pedicle, and last as shown by some of the specimens undergoes absorp-

he relation of the embryo to the parent in this singular e of gestation cannot be determined very accurately, but vascular plexus in the cup, seems to be more than is neces- for the mere nutrition of the part. The egg increases in during incubation, those ova in which development had but ıtly advanced measuring from 0·09 to 0·11 of an inch in di- ter, while those nearly mature measured from 0·14 to 0·15 n inch. How this increase of size of the embryo over the inal size of the egg is actually obtained I have no facts to r, but either of two suppositions are probable; it may be bsorption of materials from the water which surrounds it, om the capillary plexus of the pedicles, and in this case in anner analogous to that of Pipa.

mong the Siluroid fishes of Guiana there are several species, ch at certain seasons of the year have their mouths and ıchial cavities filled either with eggs or young, and as is ved for the purpose of incubation. My attention was first d to this singular habit by the late Dr. Francis W. Cragin, ıerly U. S. Consul at Paramaribo, Surinam. In a letter dated ust, 1854, he says, "the eggs you will receive are from an- r fish. The different fishermen have repeatedly assured me, these eggs in their nearly mature state are carried in the ıths of the parent, till the young are relieved by the bursting he sac. Do you either know or believe this to be so, and if ible, where are the eggs conceived and how do they get into mouth?"

In the month of April, 1857, on visiting the market of Paramaribo, I found that this statement, which at first seemed to be very improbable, was correct as to the existence of eggs in the mouths of several species of fish. In a tray of fish which a negro woman offered for sale, I found the mouths of several filled with either eggs or young, and subsequently an abundance of opportunities occurred for repeating the observation. The kinds most commonly known to the colonists, especially to the negroes, are *Jara-bakka*, *Njinge-njinge*, *Koepra*, *Makrede* and one or two others, all belonging either to the genus Bagrus or one nearly allied to it. The first two are quite common in the market and I have seen many specimens of them; for the last two I have the authority of negro fishermen but have never seen them myself. The eggs in my collection are of three different sizes, indicating so many species; one of the three having been brought to me without the fish from which they were taken.

The eggs become quite large before they leave the ovaries, and are arranged in three zones corresponding to three successive broods, and probably to be discharged in three successive years; the mature eggs of a Jara-bakka eighteen inches long, measure three fourths of an inch in diameter, those of the second zone one fourth; and those of the third or very minute, about one sixteenth of an inch.

A careful examination of eight specimens of Njinge-njinge about nine inches long, gave the following results:

The eggs in all instances were carried in the mouths of the males. This protection, or gestation of the eggs by the males, corresponds with what has been long noticed with regard to other fishes, as for example, Syngnathus where the marsupial pouch for the eggs or young is found in the males only, and Gasterosteus where the male constructs the nest and protects the eggs during incubation, from the voracity of the females.

In some individuals the eggs had been recently laid, in others they were hatched, and the fœtus had grown at the expense of some other food than that derived from the yolk, as this last was not proportionally diminished in size, and the fœtus weighed more than the undeveloped egg. The number of eggs contained in the mouth was between twenty and thirty. The mouth and branchial cavity were very much distended, rounding out and distorting the whole hyoid and branchiostegal region. Some of the eggs even partially protruded from the mouth.

The ova were not bruised or torn as if they had been bitten, or forciby held by the teeth. In many instances the fœtuses were still alive, though the parent had been dead for many hours.

No young or eggs were found in the stomach, although the mouth was crammed to its fullest capacity.

The above observations apply to Njinge-njinge. With regard to Jarra-bakka, I had but few opportunities for dissection, but in several instances the same conditions of the eggs were noticed as stated above; and in one instance, besides some nearly mature fœtuses contained in the mouth, two or three were squeezed apparently from the stomach; but not bearing any marks of violence or of the action of the gastric fluid. It is probable that these found their way into that last cavity after death, in consequence of the relaxation of the sphincter which separates the cavities of the mouth and the stomach. These facts lead to the conclusion that this is a mouth gestation, as the eggs are found there in all stages of development, and even for some time after they are hatched.

The question will be very naturally asked, how under such circumstances, these fishes are able to secure and swallow their food. I have made no observations bearing upon such a question. Unless the food consists of very minute particles, it would seem necessary that during the time of feeding the eggs should be disgorged. If this supposition be correct, it would give a very probable explanation of the only fact which might be considered at variance with the conclusion stated above, viz., that we have in these fishes a mouth gestation. In the mass of eggs with which the mouth is filled, I have occasionally found the eggs, rarely more than one or two, of another species. The only way in which their presence may be accounted for, it seems to me, is by the supposition that while feeding, the eggs are disgorged, and as these fishes are gregarious in their habits, when the ova are recovered, the stray egg of another species may be introduced into the mouth among those which naturally belong there.

5.

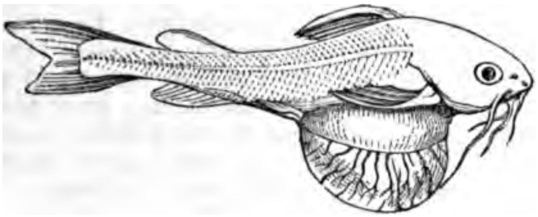


Fig. 5 represents a nearly mature fœtus of the natural size from the mouth of Bagrus, with the yolk sac partially included in the cavity of the abdomen.

Art. III.—*Some Facts respecting the Nitrates;* by John M. Ordway.

While studying the nitrates of the sesquioxyds I found it advisable, for the sake of comparison, to examine the protonitrates also, with reference to some points not generally taken into account in enumerating the properties of these salts. And as the nitrates are among the most common and important salts, it may be worth the while to exhibit these gleanings in fields often gone over but not yet entirely cleared. There are few new facts to be brought forward, but the chief object of this paper is to show the fitness of certain means for the illustration of some general truths already well known.

In most chemical text-books no good instances are given of the development of heat by mere solidification. It is indeed usually mentioned that water may be cooled many degrees below the freezing point and remain liquid, and that on congealing its temperature suddenly rises to 32° F. But the experiment is so troublesome to make, especially in the lecture room, that these truths commonly pass as matters of faith rather than of sight, and the important principles which they illustrate, often fail of being distinctly impressed on the mind of the student. Now many of the hydrated salts, and among them the nitrates, melt at points above the common temperature of the air, and are therefore well adapted for showing, at all seasons and with great ease and clearness, the inertia of bodies with regard to change of form and the liberation of sensible heat by crystallization.* Nitrate of lime is preëminently suitable for the exhibition of these properties, since after having been fused and heated above 150° F., it may be cooled in a glass vessel as low as 60°, and kept in the liquid state a long time, often for several days; but on dropping in a bit of the solid nitrate, crystallization immediately commences, and an inserted thermometer soon rises to 110° F.

A substance which may be had both liquid and solid at a temperature considerably below the melting point, is obviously very convenient for displaying the comparative densities and specific heats in the two forms, as complications caused by differences of temperature, may be entirely avoided. Thus the specific gravity of a specimen of nitrate of lime in the liquid state, at 60° F., was found to be 1·79. Some of the same was poured into oil of turpentine, made to solidify, and cooled to

* In an excellent work published in 1857,—"Lehrbuch der physikalischen und theoretischen Chemie, von H. Buff, H. Kopp und F. Zamminer,"—hyposulphite of soda is mentioned as capable of affording a very striking example of the heat becoming free during fixation; but this salt is less easy to prepare than most of the nitrates.

60° F. Its density was now 1·90. The contraction may be rendered appreciable by the eye, if we cool to a certain degree some melted nitrate contained in a long necked flask, fill with an oil up to a marked height, effect the crystallization, and then cool to the same point as before.

To illustrate the absorption of heat during the liquefaction of solids, freezing mixtures are commonly employed in which one of the ingredients, ice, is already cold. The experiment is more striking when all the articles used are at the temperature of the surrounding air. Such may be the case if we take crystallized sulphate of soda and a sesquinitrate. A mixture of 36 grams of powdered pernitrate of iron crystals and 57 grams of fine Glauber's salt, liquefied and lowered thermometer from 65° F. to zero. It readily froze water contained in a test tube. In cold weather, 8 grams of the nitrate and 9·5 grams of the sulphate brought the thermometer from 22° to −10°.*

In manufacturing salts on a large scale, the hydrometer is a very useful and ready instrument for determining when a solution is of the right strength to crystallize. But the quantities operated on in the laboratory are generally so small that the hydrometer can hardly be made available. The bulb of a thermometer, however, requires but little depth of liquor, and hence to one who wishes to prepare in the small way any of the highly soluble salts, a knowledge of the boiling points of the desired products may be of great service. Thus, finding that crystallized protochlorid of tin melts at 107° F., boils at 251°, and may be cooled to 83° without becoming solid, we see that to make this article in midsummer the evaporation of the weak solution must be continued till the boiling point gets nearly or quite up to 251°.

It should be remarked that the melting and boiling points given below, do not pretend to absolute exactness. No two different lots of the same salt are likely to give just the same figures; for it is next to impossible to get most of the hydrated salts exactly dry,—neither effloresced nor retaining mother liquor in the interstices. For any particular specimen the point of fusion can be determined with great precision. But the boiling points are high and, unless very nice precautions are taken, there will be some loss of water in heating up. So to find the temperatures of incipient ebullition, crystals were taken that were not entirely dry to start with, and the correctness of the indications was judged of after ascertaining the solidifying points of the residues.

There is, of course, no definite limit to the cooling which a melted salt may undergo without beginning to crystallize. I

* Nitrate of iron is pretty corrosive, and should not be touched with the fingers.

have here put down the lowest point at which each of the salts tried has actually been observed to remain liquid without any special precautions being taken to retard the crystallization. With some few of the nitrates it makes a difference in this respect whether they are moderately or strongly heated. If any one of them is heated but little more than is necessary to effect its fusion, it will begin to solidify before it gets many degrees below the melting point. But when the nitrates of lime, iron and chrome are brought nearly up to the boiling point, they can be cooled very low before they begin to shoot. Considering the difference in color between the solid and the liquid nitrates of iron, chrome and cobalt, there seems to be no special absurdity in supposing that some strongly heated nitrates may have to overcome a reluctance to change of state as well as one to change of form, and are therefore slower in beginning to show crystals.

The composition has in each instance been determined anew, either by simple ignition or by drying down with an excess of sulphuric acid, and so there is little room for error. It appears that a greater uniformity prevails among the nitrates than among any other salts. In all but four of those examined there are either six or three equivalents of water to each equivalent of nitric acid. In only two cases, has the same base been found capable of forming two different crystallized nitrates.

SEXHYDRATES.

Nitrate of Magnesia, $\dot{M}g\,\ddot{\bar{N}}\,\dot{H}_6$.—This salt melts at 194° F. The liquid has been cooled to 188°. It boils at 290°.

When the heating is continued, the salt remains liquid and clear till about five equivalents of water and a little of the acid are expelled. The residue is not entirely soluble. It becomes hot in recombining with water.

Nitrate of Zinc, $\dot{Z}n\,\ddot{\bar{N}}\,\dot{H}_6$.—Melts at 97½° F. It has been cooled in the liquid form to 87°. It boils at 268°.

Some of the melted crystals, on continued boiling, remained thin and clear till 42 p. c. of the weight was gone. The residue hardened to a vitreous mass on cooling, which had a composition not far from $\dot{Z}n_4\,\ddot{\bar{N}}_3\,\dot{H}_3$. This substance did not heat much when treated with water; but when some crystals were boiled till about four equivalents of water passed off, the residue evolved considerable heat in recombining with water.

Nitrate of zinc cannot be heated long without becoming basic and partially insoluble in water.

Nitrate of Manganese, $\dot{M}n\,\ddot{\bar{N}}\,\dot{H}_6$.—Melts at 78½° F. Some dry crystals liquefied in a stoppered bottle during the hot weather of June and remained melted till September, though the temperature was sometimes as low as 60°. It boils at 265°.

If the boiling is continued, decomposition soon commences and black oxyd of manganese is precipitated. This gradual formation of peroxyd is also effected by a long continued steam heat.

Some liquid nitrate at 70° F. was found to have a density of 1·8104, while the solid salt at 70° had the specific gravity 1·8199.

Nitrate of Nickel, $\dot{N}i.\ddot{N}.\dot{H}_6$.—Melts at 134° F. The liquid has been cooled to 115°. It boils at 278°.

When the boiling is continued the liquid remains clear till three equivalents of water are expelled. It then begins to thicken and parts with acid.

Nitrate of Cobalt, $\dot{C}o.\ddot{N}.\dot{H}_6$.—I had too little of this to determine accurately the melting and boiling points, but they differ little from those of the nickel salt.

Pernitrate of Iron, $\bar{F}e + 3\ddot{N}\dot{H}_6$.—Melts at 117° F. May remain liquid at 70°, after being strongly heated. It boils at 257° F.

The specific gravity of some in the liquid state at 70° F., was found to be 1·6712, while the same solidified and cooled to 70°, had a density of 1·6835.

Nitrate of Chrome, $\bar{C}r + 3\ddot{N}\dot{H}_6$.—This salt melts at about 98° F. It has been cooled to 68°. It boils at 258°.

Nitrate of Alumina, $\bar{A}l + 3\ddot{N}\dot{H}_6$.—Melts at 163° F., can be cooled to 147½°, and boils at 273°.

Nitrate of Uranium, $\bar{U}\ddot{N}\dot{H}_6$.—This beautiful salt melts at 139°. It may remain liquid at 115°. It begins to boil at 245°.

When the boiling was continued, the stuff remained thin and clear till about four equivalents of water and a little of the acid passed off. The residue gave with water a solution which was turbid at first but soon became clear. Some heat was evolved during the solution.

Nitrate of Copper.—When nitrate of copper crystallizes at a low temperature, it forms a pale blue salt having the composition $\dot{C}u\ddot{N}\dot{H}_6$. These crystals are not permanent in hot weather, for at 79½° F. they break up into a liquid and crystals of the trihydrate. To make the whole liquid requires a heat above 100° F., and so the pale crystals have no definite solidifying point.*

TRIHYDRATES.

Nitrate of Copper, $\dot{C}u\ddot{N}\dot{H}_3$.—This is the formula of the crystals which form above 79½° F. They have nearly the same shape as the sexhydrate sometimes assumes, but are deep blue and are permanent in every state of the air. The composition is erroneously given in some books as $\dot{C}u\ddot{N}\dot{H}_4$,—probably because the analysts took no pains to ascertain the dividing limit between the two salts, and tried a mixture.

* A solution of nitrate of copper is sometimes sold, standing at 55° B. As a solution saturated at 50° F. has just this strength, it is not strange that the maker often finds his returned carboys broken by huge masses of pale crystals.

The trihydrate melts at 238°. It has been cooled down to 224° before beginning to shoot. It boils at 338°.

If the boiling is continued, nitric acid immediately begins to pass off, and a green basic nitrate is deposited.

Nitrate of Lanthanum, $\dot{L}a\ddot{N}\dot{H}_3$.—This was found to melt at 104° F., and was cooled to 70° without crystallizing immediately. It boiled at 258°. These figures, however, cannot be considered as exact, for the salt used for trial amounted to but 32 grams, and was not absolutely free from didymium and cerium.

Nitrate of Glucina, $\bar{\bar{B}}e + 3\ddot{N}\dot{H}_3$.—Melts at 140° F. and may be cooled as low as 85° before it begins to fix. It boils at 285°.

Some boiled till the thermometer rose to 320°, gave off acid, but remained perfectly clear. When this residue was cooled to 61°, a crystal did not cause it to solidify, because it was too basic. But the addition of strong nitric acid, induced a rapid crystallization, the temperature rising to 142°.

When the salt was boiled not quite so long, the product could be made to solidify, but the resulting temperature was considerably lower. Dilution with a basic salt, has therefore the same effect on the melting point as dilution with water.

TETRAHYDRATES.

Nitrate of Strontia, $\dot{S}r\ddot{N}\dot{H}_4$.—Unlike any other hydrated nitrate, this salt crystallizes in the monometric system.

The composition of hydrated nitrate of strontia is always laid down in the books as $\dot{S}r\ddot{N}\dot{H}_5$. But this formula has no analogy in its favor, and having repeatedly tried good crystals formed at a low temperature I have invariably found but four equivalents of water. The nitrate crystallized above 75° F., is generally anhydrous, and that formed below 60° is hydrated, but between these temperatures there is no certainty. Thus a solution saturated at 84° F., while cooling down to 62°, deposited nothing but anhydrous crystals; and a solution saturated at 71°, by standing some hours where the thermometer did not get below 70°, gave only fully hydrated crystals.

The hydrated salt is resolved by heat into a liquid and the anhydrous nitrate. Even the hot weather of summer causes it to sweat, if kept in a close vessel. In dry air, it loses all its water by efflorescence.

Nitrate of Lime, $\dot{C}a\ddot{N}\dot{H}_4$.—Melts at 111° F. Some that was heated only to 124°, began to crystallize when it had cooled to 96°. After being heated to 153°, it remained liquid over night and got down to 57½°. This salt boils at 270°. When the boiling is continued, the mass remains liquid and clear till about one third of the water passes off. Farther heating renders it anhydrous, with scarcely any loss of acid. This dry residue evolves a strong heat in recombining with water.

Nitrate of Cadmium, $\dot{C}d\,\ddot{\ddot{N}}\,\dot{H}_4$.—This salt melts at 139° F. It has been cooled to 91° before beginning to crystallize. It boils at about 270°. On continued boiling it continues clear and thin till nearly three equivalents of water are gone. When all the water has passed off, a small portion of the remaining dry mass is insoluble.

Nitrate of Bismuth, which was formerly supposed to be a trihydrate, has been found more recently to have the anomalous composition $\ddot{B}i\,\ddot{\ddot{N}}_3\,\dot{H}_{10}$. In several trials of a pure nitrate dried over sulphuric acid, I have obtained, by ignition, 48 per cent of oxyd. This would make the quantity of water as near eleven as ten equivalents. It is barely possible then that nitrate of bismuth may be a combination of a trihydrate with a tetrahydrate and have for its true formula $\ddot{B}i\,\ddot{\ddot{N}}_3\,\dot{H}_9 + \ddot{B}i\,\ddot{\ddot{N}}_3\,\dot{H}_{12}$.

This salt is not deliquescent and does not effloresce, even when kept for a long time over sulphuric acid. It is insoluble, as a whole, in water, and does not melt clear. At 163½° F., it resolves itself into a clear liquid and one opaque solid. The mixture has been cooled to 155°, but on stirring it solidified again while the temperature rose to 163½°. Some of the liquid part decanted clear, formed on cooling a mass of crystals quite wet with acid and having altogether a composition not far from $\ddot{B}i_3\,\ddot{\ddot{N}}_{11}\,\dot{H}_{38} = 3\,\ddot{B}i\,\ddot{\ddot{N}}_3\,\dot{H}_{10} + 2\,\ddot{\ddot{N}}\,\dot{H}_4$.

ART. IV.—*Further Observations on the Allotropic Modifications of Oxygen, and on the Compound Nature of Chlorine, Bromine, &c.*; by Professor SCHÖNBEIN.*

THESE last six months I have been rather busily working on oxygen, and flatter myself not to have quite in vain maltreated my favorite; for I think I can now prove the correctness of that old idea of mine, according to which there are two kinds or allotropic modifications of active oxygen, standing to each other in the relation of + to −, *i. e.* that there is a positively-active and a negatively-active oxygen,—an ozone and an ant-ozone, which on being brought together neutralize each other into common or inactive oxygen according to the equation $(+\overset{\circ}{O})+(-\overset{\circ}{O})=O$.

The space allotted to a letter being so small, I cannot enter into the details of my late researches, and must confine myself to some general statements, which I hope, however, will give a clear notion of the nature of my recent doings. A paper will

* Addressed as a letter to Prof. Faraday, and communicated by him to the L., E. and D. Phil. Mag., xvi, 178.

before long be published in the Transactions of the Academy of Munich.

Ozonized oxygen, as produced from common oxygen by the electrical spark or phosphorus, is identical with that contained in a number of oxy-compounds, the principal ones of which are the oxyds of the precious metals, the peroxyds of manganese, lead, cobalt, nickel and bismuth,—permanganic, chromic and vanadic acids; and even the peroxyds of iron and copper may be numbered among them.

The whole of the oxygen of the oxyds of the precious metals exists in the ozonic state, whilst in the rest of the oxy-compounds named, only part of their oxygen is in that condition. I call that oxygen negatively-active, or ozone *par excellence*, and give it the sign $-\overset{\circ}{O}$ on account of its electromotive bearing. Though generally disinclined to coin new terms, I think it convenient to denominate the whole class of the oxy-compounds containing $-\overset{\circ}{O}$ "ozonids." There is another less numerous series of oxy-compounds in which part of their oxygen exists in an opposite active state, *i. e.* as $+\overset{\circ}{O}$ or antozone, wherefore I have christened them "antozonids." This class is composed of the peroxyds of hydrogen, barium, strontium, and the rest of the alkaline metals; and on this occasion I must not omit to add, that what I have hitherto called ozonized oil of turpentine, ether, &c., contain their active oxygen in the $+\overset{\circ}{O}$ state, and belong therefore to the class of the "antozonids."

Now, on bringing together (under proper circumstances) any ozonid with any antozonid, reciprocal catalysis results, the $-\overset{\circ}{O}$ of the one and the $+\overset{\circ}{O}$ of the other neutralizing each other into O, which, as such, cannot be retained by the substances with which it had been previously associated in the $-\overset{\circ}{O}$ or $+\overset{\circ}{O}$ condition. The proximate cause of the mutual catalysis of so many oxy-compounds depends therefore upon the opposite states of the active oxygen contained in those compounds.

I will now give some details on the subject.

1. Free ozonized oxygen $=(-\overset{\circ}{O})$, and peroxyd of hydrogen $=HO+(+\overset{\circ}{O})$, or peroxyd of barium $=BaO+(+\overset{\circ}{O})$ (the latter suspended in water), on being shaken together destroy each other, $HO+(+\overset{\circ}{O})$ or $BaO+(+\overset{\circ}{O})$ being reduced to HO or BaO, and $+\overset{\circ}{O}$ and $-\overset{\circ}{O}$ transformed into O.

2. Aqueous permanganic acid $=Mn^2O^2+5(-\overset{\circ}{O})$, or a solution of permanganate of potash mixed with some dilute nitric acid is almost instantaneously discolored by peroxyd of hydrogen or

of barium, the nitrate of the protoxyd of manganese rmed in the first case, and in the second, besides this nitrate of baryta. It is hardly necessary to state, that : ases the $-\mathring{O}$ of the permanganic acid and the $+\mathring{O}$ of xyd of hydrogen or barium are disengaged as O.

. aqueous solution of chromic acid containing some sulphuric acid and peroxyd of hydrogen are rapidly ned into the nitrate or sulphate of oxyd of chromium, . inactive oxygen, which is of course disengaged. A of chromic acid mixed with some nitric acid and BaO^2 similar result, nitrate of baryta and oxyd of chromium rmed, and O disengaged.

you add to a mixture of any peroxyd salt of iron and ferro-sesquicyanuret of potassium (both substances dis- ı water) some peroxyd of hydrogen, prussian blue will n down and inactive oxygen set free. On introducing ixture of nitrate of peroxyd of iron and the ferro-ses- ıret of potassium the peroxyd of barium, a similar reac- es place, prussian blue, nitrate of baryta, &c., being and inactive oxygen eliminated. From these facts it that, under certain conditions, even peroxyd of iron and BaO^2 are capable of catalyzing each other into FeO or BaO and O.

der certain circumstances PbO^2 or MnO^2 are soluble in etic acid; now if you add to such a solution HO^2 or ıe peroxyds will be reduced to HO or BaO, and PbO or active oxygen being disengaged.

s a well known fact that the oxyd of silver $=Ag(-\mathring{O})$, eroxyd of that metal $=Ag(-\mathring{O})^2$, and the peroxyd of ı $=HO+(+\mathring{O})$, catalyze each other into metallic silver, ıd inactive oxygen. Other ozonids such as $PbO+(-\mathring{O})$ $+(-\mathring{O})$, on being brought in contact with $HO+(+\mathring{O})$, sformed into PbO or MnO, HO and O. Now the per- barium $=BaO+(+\mathring{O})$, acts like $HO+(+\mathring{O})$. If you er upon an intimate mixture of AgO, or AgO^2 and lively disengagement of inactive oxygen will ensue, gO^2 and BaO^2 being reduced to metallic silver and

In concluding the first part of my letter, I must not state the general fact, that the oxygen disengaged in all reciprocal catalysis of oxy-compounds, behaves in every ike inactive oxygen.

is another set of chemical phenomena, in my opinion onnected with the polar states of the active oxygen con- . the two opposite classes of peroxyds. It is known that

a certain number of oxy-compounds, for instance the peroxyds of manganese, lead, nickel, cobalt, bismuth, silver, and also permanganic, chromic, and vanadic acids, furnish with muriatic acid chlorine, whilst another set, such as the peroxyds of barium, strontium, potassium, &c., are not capable of eliminating chlorine either out of the said acid or any other chlorid. This second class of oxy-compounds produces, however, with muriatic acid, the peroxyd of hydrogen; and it is quite impossible in any way to obtain from the first class of the peroxyds HO^2, or from the second chlorine.

You are aware that, from reasons of analogy, I do not believe in the doctrine of chlorine, bromine, &c., being simple bodies, but consider those substances as oxy-compounds, analogous to the peroxyds of manganese, lead, &c., in other terms, as "ozonids." Chlorine is therefore to me the peroxyd of murium $=MuO+(-\overset{\circ}{O},)$ hydrochloric acid $=MuO+HO$, and, as already mentioned, the peroxyd of barium $=BaO+(+\overset{\circ}{O},)$ that of hydrogen $=HO+(+\overset{\circ}{O},)$ and the peroxyd of manganese $=MnO+(-\overset{\circ}{O})$. Proceeding from these suppositions, it is very easy to account for the different way in which the two sets of peroxyds are acted upon by muriatic acid.

From reasons as yet entirely unknown to us, HO can be chemically associated only with $+\overset{\circ}{O}$, and with no other modification of oxygen, to constitute what is called the peroxyd of hydrogen; and in a similar way MuO (the hypothetically anhydrous muriatic acid of older times) is capable of being united only to $-\overset{\circ}{O}$ to form the so-called chlorine, which I denominate peroxyd of murium. If we cause $MuO+HO$ to react upon $BaO+(+\overset{\circ}{O},)$ MuO unites with BaO, and HO with $+\overset{\circ}{O}$; but if you bring together $MuO+HO$ with $Mn+(-\overset{\circ}{O},)$ part of MuO is associated to MnO, another part to $-\overset{\circ}{O}$, water being eliminated, according to the equation

$$2(MuO, HO)+MnO+(-\overset{\circ}{O})=MuO, MnO+MuO, (-\overset{\circ}{O})+2HO.$$

As you will easily perceive, from these views it would follow that, under proper circumstances, two opposite peroxyds, on being intimately mixed together and in the right proportion and acted upon by muriatic acid, could yield neither chlorine nor peroxyd of hydrogen, but merely inactive oxygen. If somewhat dilute muriatic acid be poured upon an intimate mixture of five parts of peroxyd of barium and two parts of peroxyd of manganese, the whole will be rapidly transformed into the muriates of baryta and protoxyd of manganese, the active oxygen of both the peroxyds being disengaged in the inactive condition, and

ı trace of free chlorine making its appearance. The same t is obtained from dilute hydrobromic acid.

ıother consequence of my hypothesis is this: that an inti- and correctly proportioned mixture of two opposite per- ls, such as the peroxyd of barium and that of lead, on being l upon by any oxy-acid, cannot produce the peroxyd of ogen; or, to express the same thing in other terms, muriatic must act upon the said mixture exactly in the same way as ıxy-acids do; and that is indeed the case. Mixtures of the cyds just mentioned and acetic or nitric acids, are readily erted into the acetates or nitrates of baryta and protoxyd anganese, the active oxygen of both the peroxyds being of ıe disengaged in the inactive condition.

fore I close my long story I must mention one fact more, ı, in my opinion, is certainly a very curious one. If you an aqueous and concentrated solution of bromine with a ıient quantity of peroxyd of hydrogen, what happens? A lively disengagement of inactive oxygen takes place, the · and the odor of the bromine solution disappear, the liquid mes sour, and on adding some aqueous chlorine to it, bromine ɔears. From hence we are allowed to conclude, that, on ging bromine into contact with peroxyd of hydrogen, some lled hydrobromic acid is produced. The hypothesis at ent prevailing cannot account for the formation of that acid rwise than by admitting that bromine takes up the hydrogen O^2, eliminating the two equivalents of oxygen united to H. course, take another view of the case; bromine is to me an id like peroxyd of lead, &c., *i. e.,* the peroxyd of bromium $O+(-\overset{\circ}{O})$. Now $HO+(+\overset{\circ}{O})$ and $BrO+(-\overset{\circ}{O})$ catalyze each r into HO, BrO, and inactive oxygen, BrO+HO forming obromic acid, or what might more properly be called hy- ɜ of bromiatic acid.

will be perceived that I am growing more and more hard- . in my heretical notions, or, to speak more correctly, in my ɔdox views; for it was Davy who acted the part of a here- n overthrowing the old, venerable, true creed. Indeed the er I compare the new and old doctrine on the nature of rine, &c., with the whole material of chemical facts bearing ı them, the less I am able to conceive how Davy could so ly and slightly handle the heavy weight of analogies which, ıy opinion, speak so very strongly and decisively in favor of hollet's views. There is no doubt Sir Humphrey was a man reat genius, and consequently very imaginative; but I am ɔst inclined to believe that, by a certain wantonness, or by of that transcendent faculty of his mind, he was seduced to ure up a theory intended to be as much out of the way and *ɔraisemblable*" as possible, and serve nevertheless certain

theoretical purposes; and certainly, if he entertained the intention of solving such a problem, he has wonderfully succeeded. But what I still more wonder at is both the sudden and general success which that far-fetched and strained hypothesis met with, and the tenacity with which the whole chemical world has been sticking to it ever since its imaginative author pleased to divulge it: and all this could happen in spite of the fact that the new doctrine, in removing from the field of chemistry a couple of hypothetical bodies, was, for analogy's sake, forced to introduce fictitious compounds, not by dozens only, but by hundreds,—the oxy-sulphion, oxy-nitrion, and the rest of those "nonentia." But enough of this subject, upon which I am apt to grow warm and even angry. Although the results I have obtained from my recent investigations cannot but induce me to begin another, and, I am afraid, endless series of researches, I shall for the present cut short the matter and indulge for some time in absolute idleness.

Bâsle, June 25th, 1858.

ART. V.—*Occurrence of Cobalt and Nickel in Gaston county, North Carolina;* by HENRY WURTZ, Prof. Chemistry, National Medical College, Washington.

Read in part before the American Association for the Advancement of Science at Baltimore. April, 1858. *

WHILE exploring a large tract of land in Gaston and Lincoln counties, N. C., during the summer of 1857, I found indications of the existence of ores of cobalt and nickel diffused throughout a considerable extent of country.

The region explored comprised a range of rocks composed of alternating strata of talcose and quartzose schists, which crosses the South fork of the Catawba river a little south of the line between Lincoln and Gaston counties, and in the immediate neighborhood of the falls known as the "High Shoals of the Catawba." The general direction of this range, which forms a well defined metalliferous belt of many miles in longitudinal extent, is about N. 20° E. (varying, however, in places between due N. and N. 35° E.), and at the High Shoals it is three or four miles wide. It is everywhere traversed by "veins" of quartz, carrying pyrites and other sulphids, and showing at the surface the limonite *gozzans* derived from their oxydation. These "veins" in some places have all varieties of strike and dip, although the most important ones were found most frequently to *conform in strike*

* The proper date of this paper is August, 1857, at which time it was announced to be read at the Montreal meeting of the Association. Accidents beyond the author's control have delayed its appearance until now. H. W.

r very nearly so) with the containing rocks. The dip of these cks is nearly vertical, usually a little westerly, although notable ntortions and local variations of dip were observed in a few aces. At the place where this metalliferous belt crosses the ver its boundaries appear to be, on the northwest side a thickly dded *granitoid* schist, and on the southeast side, forming the arrier over which the water falls at the High Shoals, a massive nge of peculiar feldspathic rocks, also thickly bedded in structre, and characterized by having the feldspar crystals, which e numerous and large, all arranged with their longer diameters arallel to the bedded structure, or generally about N. 20° E. n the southwesterly prolongation of this latter rock, wherever crosses any of the tributaries of the river, a waterfall is found. rowder's mountain, which towers up about a dozen miles distant a southwesterly direction, seems to lie on or near this range. Proceeding to the northeastward from the High Shoals into incoln county along this belt of talcose and quartzose schists, any places are encountered where gold has been mined, or ashed out from the beds of the small streams, among which ay be mentioned the Shuford and Cansler Gold Mines.

Many miles in the distance, but apparently on the same range, seen the high elevation in which is situated the iron mine nown as the "Graham Ore Bank." Fragments of limonite ozzan and honey-combed quartz are constantly encountered on e surface, sometimes isolated, and sometimes strewed along for nsiderable distances marking outcrops. In this part of the nge, the quartz veins are usually found to contain, wherever ey have been opened, more or less *galena, blende* and *chalcorite*, usually with native gold. In one place *rutile* was found. Going southwestwardly from the river we find the rocks prenting similar indications, and in the course of some fifteen iles, we encounter successively the "Long Creek Gold Mines," rom one of which, known as the Asbury Shaft, much gold as been taken); and a number of places where iron ore is or as been mined, known as the "Costner Ore Bank;" the "Alison re Bank;" the "Ormond Ore Bank;" the "Ferguson Ore ank," and "Briggs' Ore Bank." A few miles beyond the latter, ot far from the same range, lies the well known "Kings Mounin Gold Mine." So called "greenstone-trap dykes" are occaonally encountered, sometimes running parallel to, and somemes across, the strata. The beds of the streams frequently ontain pebbles of *black tourmaline*, and the *black sand*, so common roughout this section of the country, was found to consist here rincipally of a magnesia tourmaline, easily fusible by the blowipe. Immense veins, or rather *strata*, of black tourmaline were lso observed in several places, usually veined with milky white uartz. This would form a magnificent material for monumental

and ornamental purposes. A turnpike road was found at one spot completely covered and blackened (*paved*, as it were,) for some distance with fragment and blocks of this material, in consequence of its crossing a large outcrop very obliquely. In one place was found the outcrop of a large vein of *ilmenite*. Veins of *pyrites* were found crossing the beds of streams, where the current appeared to have washed them bare, and one such vein was observed which had a well marked *schistose* structure, similar and conformable to that of the imbedding talcose rocks, forming a true *pyrites schist*. In other places solid banks of *limonite* were found, standing in place above the surface of the ground, indicating veins (or strata ?) of pyrites below. Specimens were seen of a crystalline *hematite schist*, said to form a large vein (or stratum ?) in Crowder's mountain, but this was not visited.

It was also perfectly evident, at most of the iron ore beds before mentioned, that the ore was merely the gozzan, or product of oxydation of large strata of *sulphids*, probably *pyrrhotine*, existing below. In some of these places, as at the Ormond, Ferguson and Briggs' Ore Banks, the mining operations have penetrated, in places, to the unaltered, or only partially altered, pyrites. At the Alison and Costner Ore Banks, which are excavations into *strata* of ore from thirty to forty feet in width, the material last thrown out is a true *magnetite schist*, mixed however with much limonite.

Throughout the whole range, wherever examined, the talcose schists were found to contain, in numerous places, small seams, incrustations and stains of a *black substance*, which gave blowpipe reactions for *cobalt*. At every one of the mines above mentioned the ore, or refuse material thrown out, was found to be more or less coated with this substance. At the Ormond Ore Bank, particularly, so much of this substance was found mixed with the ore that it is probably connected with the reputation of the iron produced from this ore, for hardness and toughness, throughout the surrounding country. At the Asbury Shaft of the Long Creek Mines also, masses of quartz thrown out from the vein were found thickly incrusted with mammillary masses of this *wad*, or earthy cobalt. It cannot be doubted that it is the gozzan of some cobaltiferous sulphid existing unaltered in the rocks below. If this substance has ever attracted the attention of mineralogical explorers in this section, it has probably been mistaken for earthy manganese, from which it may readily be distinguished, however, by being very soft, smearing the fingers, and when cut with a knife exhibiting on the section a bright black lustre like that of compact graphite; and to these properties it owes the designation of "black lead," which it bears among the people of the country (to whom it is familiar).

spot about a mile in a northeasterly direction from the
eek Mines I found, crossing at right angles the road from
on to Yorkville in S. C., where the latter crosses over
ion called "Cross'" or the "Paysour mountain," the out-
ı large "vein," or stratum of the rock, which contains
ch of this black gozzan or wad. It can scarcely escape
ıtion of a person travelling along the road, as it appears
oad black band at the side of the latter. At this spot
res about fifteen feet in width. A small opening was
o it three or four rods from the road on the southern
. it was found to be about twelve feet wide, included be-
alls of talcose slate, but so highly decomposed that no
ıry evidence could be obtained of its character where
ed. It was traced and opened again about half a mile
ıterly from the road, and found to consist there of a
of parallel strata, separated by seams of talcose schist
vo feet wide. The largest of these strata was ten feet
esenting a solid bank of limonite, mixed with a little
o compact that it was with difficulty broken by a pick.
ıg the Yorkville road southerly from the point where
crosses it, are encountered, interstratified with the tal-
sts, several narrow bands of a granular quartzose schist,
nding precisely in character to the *itacolumite* of Hum-
pposed to be the gangue of the *diamond.* No diamonds
wever, to my knowledge, yet been found in this imme-
ighborhood, although known localities of the gem are
listant. In places this itacolumite is highly granular and
ınd would be called a *saccharoid* quartz schist. Such
ıs call strongly to mind the so-called *flexible sandstone* of
ell Co., N. C., but no flexible specimens were observed.
ving the vein northwardly from the road, the outcrop
ıd to descend rapidly along the western slope of Cross'
n, and at about a quarter of a mile from the road was
spot where the ground consisted in great part of frag-
' the black cobaltiferous substance. Openings properly
re would probably lead to interesting and valuable de-
nts. A determination of the quantity of mixed oxyds
t and nickel contained in the mineral found at this spot,
26 per cent. The presence of oxyd of nickel in con-
e proportion in this mixture was proved by the method
g,* that is, by passing for some time, in the cold, a
urrent of chlorine gas through the solution of the mixed
o which has been previously added large excesses of
of potassium and caustic soda, the nickel being thus
down as a black precipitate of Ni^2O^3. No quantitative
ıation of the proportion of oxyd of nickel, however,
been made.

* Annalen der Chemie und Pharmacie, lxxxvii, 128.

This Cross' Mountain gozzan was found, by qualitative analysis, to contain besides *cobalt*, *nickel*, *manganese* and *iron*, small quantities of *copper*, *bismuth*, *zinc*, *lime*, *alumina*, *magnesia* and *glucina*. Traces of *sulphur* were also ascertained by Mr. Jas. R. Brant, to whom I am indebted for some assistance in the examinations. No traces of arsenic could be found.

In the mineral from the Asbury shaft, qualitative examination detected *iron*, *manganese*, *cobalt*, *nickel*, *copper*, *bismuth*, *zinc*, *alumina*, *silica*, *lime* and *magnesia*, besides traces of something which seemed to give the reactions of *tellurium*.* *Sulphur* in traces was found by Mr. Brant, but arsenic was sought for without success.

The substance from the Ormond Ore Bank may be called a cobaltiferous *earthy manganese*, or granular and amorphous *hausmannite*. It gives with chlorohydric acid a deep brown-black solution with evolution of chlorine (like hausmannite), which so-

* That this is really tellurium seems more probable in view of the unmistakeable indications obtained of the presence of the allied element, bismuth. These two elements, which form the connecting links between the arsenic and sulphur groups, seem, like Ni and Co, Ag and Pb, or Br and I, to preserve (at least in our American localities) a certain degree of concomitance in their occurrence. Thus the first known locality of both Bi and Te in the United States was announced by Prof. B. Silliman, Sen., in the first volume of the Am. Jour. of Science, p. 312, at Huntington, Conn. No further discovery of Te in the United States was recorded until Dr. Jackson's announcement of its existence at Whitehall, near Fredericksburg, Spotsylvania Co., Va., in the Am. J. Science for May, 1848, in the form of *tellurid of bismuth* or tetradymite. Since then tetradymite has been found at other Virginian localities, as the "Tellurium Mine," Fluvanna Co., and the "Monroe Mine," Stafford Co., and by Genth at several places in North Carolina, as at the "Phœnix" and "Boger Mines" in Cabarrus Co., and near the "Washington Mine" in Davidson Co. The only *South American* specimen yet described containing Te was a tellurid of Bi brought to Paris by Claussen from San José in Brazil, in which Damour found 79 p. c. Bi and 16 p. c. Te, with a little Se and S (see Ann. de Ch. et de. Ph., [3], xiii, 372). *Bismuth*, which, it will be observed, was found in small quantity in each of the three specimens examined, appears to be a rather common constituent of our crystalline schists. Besides the "Bismuth Mine" at Huntington, Conn., before alluded to, and the other long known localities at Trumbull and Monroe, Shepard has found it at Haddam, Conn. (Am. J. Sc., [2], xii, 220) and Jackson at the "Lubec Lead Mines" in Maine. The locality at "Brewer's Mine" in Chesterfield District, S. C., the *bismutite* from which was analyzed by Rammelsberg (Pogg. Ann., lxxvi, 564) and Genth (Am. J. Sci., [2], xxiii, 426) has long been known. In Genth's analysis an appreciable quantity of Te was found. Besides the several localities of tetradymite in Virginia and North Carolina before mentioned, Genth found *bismuthine* at Gold Hill, Rowan Co., N. C. (Am. J. Sci, [2], xix, 16), and Jackson states that *bismuth ochre* occurs with the Virginian tetradymites (Dana's Mineralogy, p. 141), and moreover, Genth has very recently (Am. J. Sci., [2], xxiii, 427, May, 1857) brought forward as a new locality of bismutite in North Carolina, *Gaston County* itself, where he says it was discovered by Dr. Asbury of Charlotte, the gentleman, if I mistake not, from whom the "Asbury Shaft" derives its name. In this also Genth obtained indications of the presence of *tellurium*.

With regard to South American localities of bismuth, besides the above-mentioned Brazilian tellurid of Damour, two others have thus far been recorded; one of which is at the mine of San Antonio, near Copiapo, Chili, whence was obtained a *bismuthet of silver*, containing, according to analysis of Domeyko, 10 p. c. of Bi, (Dana, p. 16), and the other is Rammelsberg's *chiviatite*, from Chiviato, Peru, a sulphid of Pb, Cu and Bi, containing 61 p. c. of Bi (Dana, p. 77).

lution contained *iron*, *manganese*, *cobalt*, *nickel*, *copper*, *bismuth*, *alumina*, *glucina*, and traces of *baryta*, *lead* and *magnesia*. There were in this also traces of *sulphur*, but no arsenic.

The Asbury Shaft and Cross' Mountain minerals give deep beautiful grass-green solutions in chlorohydric acid, with evolution of chlorine, which solutions become yellow-brown on adding water, a behavior characteristic of solutions containing considerable quantities of cobalt with iron, and by which these cobaltiferous wads may generally be distinguished from ordinary earthy manganese containing but traces of cobalt or none.

As to the nature of the *unaltered mineral*, from which these cobaltiferous gozzans have been derived by oxydation, it is possible to form a very probable hypothesis. The absence of *arsenic*, not only from these, but from many other minerals that I have examined from this region,* leads to the conclusion that this unaltered mineral must be a *sulphid*, and not an *arseniet* of cobalt and nickel, and the great resemblance of these substances to the cobalt and nickel ore from *Mine la Motte* in Missouri, which is also a product of oxydation, is presumptive evidence that the original mineral may be identical with, or at least similar to, the one existing there. Now this original mineral at Mine la Motte has recently been found by Dr. Genth† to be *siegenite*, containing 30·53 per cent of nickel and 21·34 of cobalt, together with iron and traces of lead, copper and antimony. The fact that the products of oxydation at the Cross' Mountain locality contain but 13 per cent of oxyds of cobalt and nickel is not against this hypothesis, for in the oxydation of such a mixture of sulphids, the produced sulphates of cobalt and nickel, particularly the latter, would be in great measure washed away,‡

* Arsenic indeed appears to be a sparsely distributed constituent of the schists of the Carolinas. Hardly any reliable *analytical* evidences of its occurrence in these latitudes are in existence. We have, however, one such evidence. A mineral found in minute quantities at the bismuth locality in Chesterfield District, S. Carolina, on analysis by Dr. Genth proved to be a sulpharsenate of sulphid of copper, most probably identical with the Peruvian species *enargite* (Am. J. Science, [2], xxiii, 420). Dana also (p. 62) mentions one specimen of *leucopyrite* found in Randolph Co., N. C.

† Am. Jour. Science, [2], xxiii, 419.

‡ It will be remembered that these two sulphates occur naturally, as *bieberite* and *pyromeline*, both products of oxydation of their corresponding sulphids. With regard to the relative tendencies of cobalt and nickel, when in *neutral* or *acid* solution, to undergo oxydation and precipitation as cobaltic and nicklic oxyds, our knowledge is rather meagre, but still experimental evidence bearing upon this point is not wholly wanting. Thus Dr. Gibbs found (Am. J. Science, [2], xiv, 205) that deutoxyd of lead partially oxydizes and precipitates Co from its solutions, but Ni not at all. This suffices to account for the fact that among the numerous analyses of *wads*, *earthy cobalts* and *bog manganese ores* on record, the presence of Ni is seldom or never indicated. The reason why, in *alkaline* solutions, as in the presence of an excess of ammonia or cyanid of potassium, the reverse action takes place, and the Ni is thrown down, while the Co remains in solution, is simply the eminent capacity which cobaltic oxyd possesses to form soluble double salts and conjugated compounds, a tendency apparently not shared by nicklic oxyd.

whilst the iron and manganese, passing to higher states of oxydation, would remain behind in insoluble forms. I cannot therefore refrain from offering the hypothesis that these veins, when opened to a depth below the influence of surface oxydation, will be found to contain either siegenite, or some nearly related species. As relevant to this view, I may cite the fact that Dr. Genth has recently discovered siegenite,* associated with chalcopyrite, pyrites, blende, etc., in the vein worked at the Mineral Hill Mine, Carroll Co., Md., in the same range of metamorphic schists as these North Carolina localities.

The only place in this neighborhood where a vein has been opened to a sufficient depth to expose the character of the unaltered ore, is what is called the "Bronson Shaft," at the Long Creek Mines, which has been recently worked for gold by a New York company, and is situated about half a mile southwesterly from the Asbury Shaft, and either on the same vein with the latter or on a closely parallel one. At this spot, however, unfortunately none of the black cobaltiferous substance occurs with the ore. I examined this mine and found that near the surface and above water level, the mineral mixed with the quartz gangue of the vein is principally limonite, as usual. Below water level, or about forty feet from the surface, the limonite begins to disappear, and the vein gradually assumes the character of a porous mass of quartz filled with strings and bunches of *pyrites* and "vugs" or cavities lined with crystals of the same, sometimes of the octahedral variety. Beautiful specimens were found containing contiguous cavities, some lined with cubic, and others with octahedral crystals, in the same specimen. The whole mass of the vein is here saturated, of course, with water. On descending to the bottom of the shaft, about 140 feet from the surface, the vein is first found *compact* and apparently unaltered, being here about eight feet wide, and composed of a mixture of quartz and *pyrrhotine.*

This pyrrhotine contains, however, but traces of cobalt and nickel. I wish to ask here whether it is not evident from the above facts, that the pyrites, as well as the limonite, found in the upper part of the Bronson shaft, is clearly a product of the action of aerated water upon the pyrrhotine? The pyrrhotine is compact and massive, with a granular fracture,† and no specimens were found in the bottom of the shaft presenting indications of crystallization, whilst all the pyrites found above presents, as before stated, an eminently crystalline structure, an in-

* Am. Jour. of Science, [2], xxiii, 418.

† The fractured surface presents a number of small patches of *chalcopyrite.* I may mention here that Prof. Emmons, in his recent Geological Report on North Carolina (pp. 167, 168) calls this pyrrhotine of the Long Creek Mines "arsenical pyrites." I could find, however, no trace of arsenic. It almost wholly dissolves in warm chlorohydric acid with copious evolution of sulphohydric gas.

dication, according to the crystallogenic views which are rapidly being generally adopted at the present day, of the agency of *water*, at or near the ordinary temperature, in its formation. Considering, for the sake of simplicity, as Breithaupt, von Kobell, Frankenheim and Rammelsberg have done,* that pyrrhotine is *protosulphid* of iron, the action of oxygeniferous water upon it in the formation of pyrites and limonite, may be represented by the rather simple equation

$$3FeS+2\tfrac{1}{2}HO+2O=FeS^2+Fe^2O^3,\ 1\tfrac{1}{2}HO+HS,$$

the sulphohydric acid formed entering into solution in the water, and subsequently either undergoing oxydation in its turn, or issuing in sulphur springs.†

ART. VI.—*On the so-called Triassic Rocks of Kansas and Nebraska;* by F. B. MEEK and F. V. HAYDEN.

IN several of our publications on the geology of Nebraska, we have mentioned a formation (No. 1 of the Nebraska Section) consisting of reddish and yellow sandstones, and various colored clays, with seams and beds of impure lignite, holding a position at the base of the Cretaceous series of the northwest. Although entertaining some doubts respecting the exact age of this formation, we have always placed it provisionally in the Cretaceous system, in our published sections.

Having learned through Mr. Hawn that a precisely similar group of strata, holding apparently the same position, occurs in northeastern Kansas, we placed these latter beds on a parallel with No. 1 of the Nebraska section, in a paper read before the Phila. Acad. Nat. Sci., May, 1857. Soon after the publication of this paper, however, a few fossils Mr. Hawn had shipped to us some time before, from a bed near the base of a section of the Kansas rocks he had furnished us for publication, came to hand. On examining these fossils, we at once discovered they were not, as had been supposed, Cretaceous forms, but similar to those of the Permian of the Old World. From this it became manifest that in drawing a parallel between the Kansas and Nebraska formations, we had carried No. 1 too low in Kansas, by bringing it down so as to include the bed from which these fossils had been obtained.

* Handwörterbuch der Chem. Lieb. Pogg. and Woehler, v, 62.

† These views will be recurred to in a future communication, to be presented whenever I shall have been able to complete my chemical examinations of the minerals collected in this section, and in which I propose to bring forward some general considerations regarding the metamorphism of the crystalline schists of the United States, and the nature and origin of the included metalliferous veins.

This misunderstanding in regard to the lower limits of No. 1, in Kansas, also led us to place on a parallel with that formation, all the lower two-hundred feet of Mr. Marcou's Pyramid Mountain section, (New Mexico) referred by him to the Trias. Suspecting however, that No. 1, as thus defined, might possibly include beds not properly belonging to it, we distinctly stated in the closing remarks of the same paper, that we yet wanted positive evidence, we might not be making it include beds older than any part of the Cretaceous system.

Although we are now aware that in drawing this parallel between the Nebraska rocks and those of Kansas and New Mexico, we carried No. 1, too low, we yet regard all, or nearly all of Mr. Marcou's Pyramid Mountain section, referred by him to the Jurassic System, as equivalent to the Cretaceous formations No. 1, 2 and 3, of Nebraska; while the lower two hundred feet of the Pyramid Mountain referred by Mr. Marcou to the Trias, we think equivalent to the Kansas deposits between the base of No. 1, as we now understand it, and the beds containing the Permian fossils.

In our paper on the collections brought in by Lieut. Warren's expedition to the Black Hills, read before the Acad. Nat. Sci., Philad., March, 1858, we remarked that in consequence of the occurrence in No. 1, of the genus *Baculites*, and numerous leaves closely resembling those of some of the higher types amongst our existing dicotyledonous forest trees, we thought we were hazarding little in referring it to the Cretaceous epoch.

More recently Mr. Hawn has published a paper in the Transactions of the St. Louis Acad. Sci. in which he places this formation in Kansas and New Mexico (as we had done), on a parallel with No. 1, of the Nebraska section, but refers the whole to the Trias.*

This difference of opinion caused us to examine with no little interest, during our recent expedition to Kansas, some of the localities mentioned by Mr. Hawn, near the junction of the Grand Saline and Smoky Hill branches of Kansas river, with the view of determining definitely whether or not the formation regarded by him as Triassic, could really be the same as No. 1 of the Nebraska section. In this we were particularly successful, for we not only found these Kansas formations agreeing exactly in all the details of their lithological characters, with No. 1, in Nebraska, but we also discovered in them several good specimens of the same dicotyledonous leaves so abundant in No. 1, at the mouth of Big Sioux river, and at Blackbird Hill, on the Missouri, in Nebraska. Associated with these leaves we likewise found specimens of the same peculiar trilobate leaf

* Trias of Kansas, by F. Hawn, Trans. St. Louis Acad. Sci., vol. i, p. 171.

(*Ettingshausinia*) mentioned by Mr. Hawn* as occurring in the formation referred by him to the Trias, thus establishing beyond the possibility of a reasonable doubt, the identity of the supposed Triassic deposits of Kansas, and No. 1, of the Nebraska section.

In regard to the leaves here referred to, we would merely remark that they are quite abundant in this formation, both in Nebraska and Kansas, and certainly belong to higher and more modern types of dicotyledonous trees, than have yet been found even in Jurassic rocks. Dr. J. S. Newberry our excellent authority in fossil botany, to whom we have submitted the whole collection, decidedly concurs with us in the opinion that the rocks in which they occur cannot be older than lower Cretaceous. In a communication recently received from him respecting these remains he says: "They include so many highly organized plants, that were there not among them several genera exclusively Cretaceous, I should be disposed to refer them to a more recent era."

"A single glance is sufficient to satisfy any one they are not Triassic. Up to the present time no angiosperm dicotyledonous plants have been found in rocks older than the Cretaceous, while of the eighteen species which comprise your collection sixteen are of this character." * * * *

"The species of your fossil plants are probably all new; though generally closely allied to the Cretaceous species of the Old World. From the limited study I have given them I have referred them to the following genera:

Sphenopteris.	Pyrus?
Abietites.	Alnus.
Acer.	Salix.
Fagus.	Magnolia.
Populus.	Credneria.
Cornus.	Ettingshausinia."
Liriodendron.	

"Of these the last two are exclusively Cretaceous, and highly characteristic of that formation in Europe.

* * * * * * *

"I may say in confirmation of the assertion that your fossil plants are Cretaceous, that I found near the base of the yellow sandstone series in New Mexico, considered Jurassic by Mr. Marcou,—a very similar flora to that represented by your specimens, one species at least being identical with yours, associated with *Gryphæa*, *Inoceramus*, and *Ammonites* of lower Cretaceous species."

* Prof. Swallow exhibited a specimen of this species at the Baltimore meeting of the Am. Association.

We have only to add in regard to the formation under consideration that we think it will no longer be doubted that it really belongs where we have always placed it, in the Cretaceous System.*

Between the base of No. 1 and the beds from which the Permian fossils are obtained in Kansas, there is a considerable thickness of red, blue, green and whitish clays, with a few beds of sandstone, and near the base gypsum deposits. This series may,—at least in part,—be Jurassic or Triassic or both, (much more probably the former), but until we have some reliable palæontological evidence, it would only be groping in the dark to attempt to define its age; knowing as we do that lithological characters are of no value whatever, as a guide in drawing a parallel between these formations and those of the Old World.

As we expect soon to publish a paper giving in more detail the results of our examinations amongst the rocks in which so many Permian fossils have been found in Kansas, we would merely remark here that the coal measures of that region pass upwards by imperceptible gradations into an extensive series of rocks, consisting usually of rather impure more or less magnesian limestones, alternating with generally much thicker beds of blue, green, red and ash-colored laminated clays or very soft shales, with occasional beds of sandstone. Into this series, nearly all the species of fossils found in the middle and intermediate coal measures pass in great numbers.† Associated with these however, we occasionally meet with fossils belonging to types regarded in the Old World as characteristic of the Permian epoch.

* After the reception of a brief preliminary report by us, published last winter in the National Intelligencer, on the collections brought in from the Black Hills by Lieut. Warren, Mr. Marcou published a paper in the *Archives des Sciences de la Bibliotheque Universelle* of Geneva (a translation of which has recently appeared in the New York Mining Journal) in which after speaking of some points of difference in our opinions respecting the geology of the far west, he says, "in other respects the series of Messrs. Meek and Hayden agrees perfectly with mine, and it is with great pleasure I see that these learned geologists admit not only the existence of the New Red Sandstone (Permian and Trias) and Jurassic, but that they are led to regard as Jurassic, formation No. 1, of their Nebraska Cretaceous Series, a formation which from their description, I have no hesitation in regarding as Jurassic."

It was perhaps owing to the necessary brevity of our preliminary statement of the Jurassic and other discoveries in the Black Hills, seen by Mr. Marcou in the Intelligencer, that he misunderstood us. We have no where said we had recognized the Trias in the northwest; nor have we admitted in any of our publications that No. 1, of the Nebraska section is Jurassic. We stated that in consequence of the similarity between the lithological characters of No. 1, and the Jurassic deposits in the Black Hills, and the absence of organic remains near the junction, we were in doubt respecting the particular horizon at which the line should be drawn between them. At the same time, we stated that the beds from which the Jurassic fossils, described by us were obtained, hold a position *below* No. 1, of the Nebraska section.

† Amongst these we recognize nearly all the Carboniferous fossils figured by Mr. Marcou in his "Geology of North America."

As we ascend in this group of strata, which comprises, nearly or quite all the lower Permian, and much of the upper coal measures of Prof. Swallow's and Mr. Hawn's section* we find the Carboniferous forms very gradually diminishing in numbers to be replaced by Permian types, or others rather intermediate in their affinities, between those of the Permian and Carboniferous epochs.

Still higher in the series, without passing any horizon of unconformability, or meeting with any *abrupt* change, either in the fossils, or the lithological characters of the rocks, we find, when fairly up into the Upper Permian of Prof. Swallow's and Mr. Hawn's section, that we have lost sight of nearly, or quite, all the coal measure types, and meet only with Permian forms.

From these facts, we are inclined to the opinion that the entire series, from near the top of the Lower Permian of Prof. Swallow's and Mr. Hawn's section, down even lower than the horizon where they draw the line between the coal measures and the lower Permian,† should be regarded as intermediate in age, and as filling the hiatus between the Permian and upper coal measures of the Old World; while we think only the Upper Permian of their section really represents the Permian rocks, as developed on the other side of the Atlantic.

This intermediate series might be very appropriately termed the Permo-Carboniferous group, to indicate its relations both to the Permian and Carboniferous rocks. In case however, it may be thought best, in order to avoid the inconvenience of introducing a new name into our nomenclature, to class it along with either the Permian or Carboniferous, we would certainly place it in the latter, since Carboniferous types greatly predominated in its fauna.

In conclusion we would state that there is no unconformability so far as our knowledge extends, amongst all the rocks of Nebraska and northeastern Kansas, from the coal measures to the top of the most recent Cretaceous. The whole series in N. E. Kansas, and along the Missouri, as far up as Heart river in Nebraska, where the latest Cretaceous deposits pass beneath the water level, dip to the northwest. Consequently the elevating forces that produced this inclination of these various formations, must have been called into play—as in the region of the Black Hills,—after the close of the Cretaceous epoch, and previous to the deposition of the Miocene Tertiary formations of the northwest.

* Transactions St. Louis Acad. Sci., vol. i, p. 171.

† We found the genus *Monotis* ranging down several hundred feet below the base of what we understand to be the lower Permian in Prof. Swallow's and Mr. Hawn's section.

ART. VII.—*On Lazulite, Pyrophyllite and Tetradymite in Georgia*; by CHARLES UPHAM SHEPARD.

WHILE at Allatoona, Ga., in April last, Mr. S. Harris of that place received a small blue crystal from Dr. Stephenson of Lincoln county, the name of which the Doctor wished to learn. It being handed over to me for determination, I found it to be Lazulite. The form of the crystal was well defined, and wholly different from any specimens I had ever seen from Lincoln county, or from elsewhere. This decided me to visit the locality if possible, on my way back to Charleston. On making the necessary inquiries for my route, I learned with surprise, that instead of coming from Lincoln county, N. C., it was from a county of the same name in Georgia, the two being several hundred miles apart.

Want of time however, prevented my reaching nearer than within twelve miles of the spot; but I was fortunate to obtain the assistance of Dr. Stephenson in procuring a supply of the mineral. He was good enough to visit the locality twice, attended by two miners; and has favored me with a description of the circumstances under which lazulite occurs.

The locality is upon Graves' mountain, a ridge three hundred feet high and two miles in length. This elevation is situated about twelve miles northwest of the short auriferous belt, known as the Columbia gold mines in a county of the same name, lying fifty miles above Augusta. Graves' mountain is supposed to be the southwestern terminus of a second parallel gold belt, which extending across South Carolina, includes the famous Dorr mine, and afterwards runs away into North Carolina. The central part of the mountain, to the thickness of fifty feet, is composed of a hematitic rock, which includes in some places an abundance of a ferruginous kyanite, much resembling in appearance the diaspore from the Urals. With the kyanite is found rutile, often in gigantic crystals (weighing upwards of a pound), and possessed of much regularity of crystalline form. The prevailing figure is a square prism with truncated lateral edges, and surmounted at both extremities by an eight-sided pyramid. There is also found a most remarkably perfect twin crystal, in which the geniculation is six times repeated,—producing an hexagonal prism, surmounted at each end by a six-sided pyramid, with a reëntering, six-sided, hopper-shaped cavity, at the tips. These crystals are all more remarkable for their symmetry and polish, than any I have ever seen. Some are fully equal in lustre to the brilliant crystals of cassiterite from Cornwall or Bohemia. The most perfect rutiles are generally imbedded in the massive kyanite; and when detached leave behind impressions having a

polish and lustre equal to that of their own planes. A little common quartz is also mingled with the kyanite and rutile. Occasionally small imbedded crystals of quartz, of the form of those found in the Trenton limestone of New York, are seen in the kyanite.

Closely associated with kyanite, rutile and quartz, are considerable masses (eight or ten inches thick) of a mineral known among the miners of Georgia as steatite, but which is true pyrophyllite,—differing in no respect from that of the Urals, except in the finer stellulations it presents, and in the slight ferruginous stain it exhibits near their centres.

The hematite is massive, granular (approaching compact); but the masses are somewhat open, from including the decomposing ferruginous kyanite, particles of pyrophyllite and even portions of compact rutile. The large masses consequently possess a somewhat slag-like and roughened aspect; and suggest, on being handled, the presence of some native metal. It is possible that this hematite may contain titanium as a constant ingredient; in which case it may prove a new mineral.

To the southeast of this fifty feet band, appears the itacolumite, with a thickness of more than three hundred feet, which presents numerous included zones or layers, varying from one to three feet in thickness, in which is found imbedded, masses and crystals of lazulite. The continuity of the lazulite is by no means perfect,—the mineral rather exhibiting a tendency to form nests and bunches. Within a few feet of the surface, the rock is loose and sandy, and presents a pale buff color; but at a depth of three feet, it approaches compactness, with a greyish white color. It is obscurely schistose, with a tendency only to cleavage, and at intervals not nearer than two or three inches. The lazulite is almost wholly in crystals, varying from a quarter to one inch in length; and are scattered like garnets through granite or mica slate, presenting a very pleasing appearance from the contrast between the ultramarine blue of the mineral, and the clear, pale buff of the rock.

The itacolumite contains traces of gold, especially near the southern extremity of the formation, where it becomes more schistose and embraces minute crystals of pyrites. It has here been worked to some extent for the precious metal.*

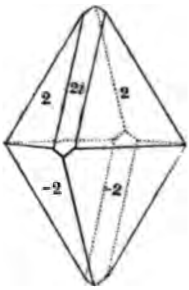
* The aspect of many specimens of the hematitic mixture of kyanite and quartz suggests a resemblance to the diamond gangue of Brazil; and I can but regard this spot as well worthy of being examined for the diamond. Dr. Stephenson informs me that at least ten crystals of this gem have been found in Burke county, two in Habersham, two in Hall and one in Union county. The largest of these is said to have sold for $150 in Philadelphia. The whole number of diamonds thus far found in the United States cannot therefore be less than thirty, nearly all of which occurred in itacolumite.

A greenish, massive kyanite, with scales of white mica (often partially decomposed so as to resemble talc), occurs very rarely in little bunches, in the vicinity of the lazulite crystals. Among these, the naked eye often detects minute and nearly transparent red crystals of rutile. Those of a still smaller size, and visible only with the aid of a lens, are pretty widely diffused through the rock, and often coat the rough surfaces and joints of the lazulite crystals themselves.

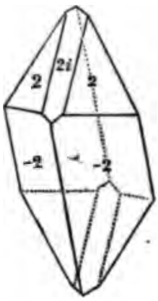
Small drusy cavities very rarely occur in the itacolumite, pretty nearly filled with barytes, massive and crystalline. Very minute and perfectly formed transparent crystals of quartz are discernible in the barytes, likewise microscopic crystals of sulphur. The form of the barytes is that represented in fig. 513 of Dana, coming from the gold formation (itacolumite?) of Fauquier county, Va.

The crystals are represented by the following figures, obligingly furnished by Prof. Dana; and are lettered in accordance with the figure of a lazulite crystal on p. 404 of his Mineralogy. The rarest of these forms is figure 1, of which I have

1.



2.



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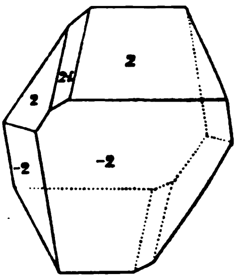


detected only three crystals. Fig. 2 is very common, and is the result of a vertical elongation of the crystal, producing a slightly rhombic prism with very oblique dihedral summits, having slightly truncated edges. The planes $2i$ are always much narrower than in the figures. The crystals of the form of fig. 2 are always small, rarely above one-third of an inch in length. Figs. 3 and 4 are unsymmetrical modifications of fig. 1, in which the right hand planes 2 and −2 are horizontally prolonged, and in fig. 4 are possessed of very unequal dimensions, thus giving rise to a very flattened crystal. The crystals of fig. 3 are the largest found, sometimes measuring above one inch in length.

4.

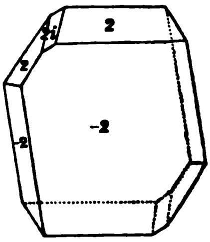
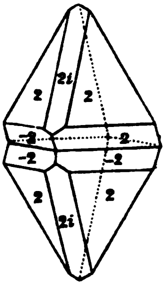


Figure 5, a twin, is by far the most abundant form, equalling in frequency all the others combined. It results from the composition of two such forms as figure 1. The plane of composition is coincident with the rhombic base of the figure; and the angle of revolution =180°.

5.



The faces of none of these crystals are sufficiently polished to allow of the use of the reflecting gonimeter.

The color of the lazulite is various shades of berlin and indigo blue. The effect of weathering is, to lower the intensity of the blue, and rarely to give rise to a shade of green.

Tetradymite in Lumpkin county.

An important discovery of gold has been made during the last summer in the middle of the Chestatee river, four miles east of Dahlonega. It occurs in seams in hornblendic gneiss. Accompanying the gold were found considerable quantities of a white foliated massive mineral, having nearly the color and lustre of tin, which was taken for silver by the miners, though to others it suggested the idea of platinum and even of molybdenite. Several specimens were forwarded to me for examination by Dr. M. F. Stephenson and by W. F. Harris, Esq. I find it to be tetradymite, a species I had before observed in small quantities along with gold, at the Pascoe mine in Cherokee county, and at a place near Van Wort in Polk county.

From the specimens sent, it appears that the gangue of the mineral is gneiss; though in a specimen from Mr. Harris it is diffused in seams through granular white calcite, rendering the mass as heavy as barytes, for which substance it appears, on this account, to have been mistaken.

In both gangues, it is attended by gold.* A number of specimens of the gneiss included with quartz veins, were sent to me for inspection. The quartz veins are transverse to the stratification of the gneiss, and vary in thickness from one to two inches. They contain irregularly shaped masses of pyrrhotine (intermingled with traces of chalcopyrite), chlorite, angular fragments of green hornblendic gneiss, cleavable calcite, ilmenite in broad highly curved crystals, to which may be added a few crystals of allanite and grains of yellow apatite.† A few

* As it has a very pale brass-yellow color and assays at the mint only from 717 to 800, while the deposit gold in the vicinity varies from 910 to 920, it is possible it may be an alloy of gold and bismuth, analogous to the sample I examined several years ago from the Charlotte, N. C., mint, and for which, in the event of its occuring in nature, I have suggested the name of Bismuthaurite.

† This is the only instance in which I have detected apatite in the Southern states; where beryl, also, appears to be equally rare.

grains of reddish garnet are also visible in the gneiss, near its junction with the quartz veins.

The tetradymite is a very handsome metallic mineral. It is broadly laminated for the most part, though sometimes approaching granular in structure. In one instance it is reported to have occurred in foliæ three or four inches across. I have not seen it in perfect crystals. It contains very rarely, minute forms of a silver-white pyrites not yet determined. The tetradymite when first heated before the blowpipe, evolves a distinct odor of selenium.

When in granular calcite, it is accompanied by small crystals of a brownish, semi-transparent mineral, in prisms resembling tourmaline, but whether they belong to this species I have been unable to determine.

Leadhillite occurs in small quantity at the Morgan silver lead mine, in Spartanburg district, South Carolina. It is associated with pyromorphite and cerusite.

ART. VIII.—*Address by Lord Brougham on the Inauguration of a Statue to Sir Isaac Newton.**

To record the names and preserve the memory of those whose great achievements in science, in arts, or in arms have conferred benefits and lustre upon our kind, has in all ages been regarded as a duty and felt as a gratification by wise and reflecting men. The desire of inspiring an ambition to emulate such examples generally mingles itself with these sentiments; but they cease

* From the London Times, September 23.

GRANTHAM, Tuesday, September 21, 1858.—Lincolnshire enjoys the proud distinction of having given to the world the illustrious mathematician and philosopher, Sir Isaac Newton—justly described as "the greatest genius of the human race"—who was born at the manor-house of Woolsthorpe, a hamlet eight miles from this town, on Christmas Day, 1642. Sir Isaac was a posthumous child, his father having died, at a comparatively early age, some three months before the birth of a son whose reputation will endure "to the last syllable of recorded time." Mrs. Newton re-married, and the embryo philosopher seems to have remained under the care of his maternal grandmother and uncle until he attained the age of twelve, when he was sent to the grammar-school at Grantham. While at school he displayed an extraordinary inclination for mechanics, and busied himself, during the time devoted by his schoolmates to play, in making models of various kinds, chiefly clocks and sun dials, one of the latter of which is still to be seen carved upon the walls of the old manor-house at Woolsthorpe. He was entered, in 1661, at Trinity College, Cambridge, where he was fortunate enough to secure the friendship of the learned Dr. Isaac Barrow, who had been elected Greek Professor in 1660, and who became Lucasian Professor in 1663. In the autumn of 1667, Newton was elected a minor fellow; on the 16th of March, 1668, he was elected a major fellow; and on the 29th of October, 1669, he was appointed Lucasian Professor, in the room of Dr. Barrow, who is said to have resigned with a view to his appointment, and from this period may be dated the development of those wonderful scientific discoveries which have given him a world-wide and time-enduring reputation. It is unnecessary to trace further the career of this great philosopher, over whose giant intellect a sad

not to operate even in the rare instances of transcendent merit, where matchless genius excludes all possibility of imitation, and nothing remains but wonder in those who contemplate its triumphs at a distance that forbids all attempts to approach. We are this day assembled to commemorate him of whom the consent of nations has declared that he is chargeable with nothing like a follower's exaggeration or local partiality, who pronounces the name of Newton as that of the greatest genius ever bestowed by the bounty of Providence for instructing mankind on the frame of the universe, and the laws by which it is governed:

> "Qui genus humanum ingenio superavit, et omnes
> Restinxit; stellas exortus uti ætherius sol."—(*Luc.*)

> "In genius who surpassed mankind as far
> As does the mid-day sun the midnight star."—(*Dryden.*)

But, though scaling these lofty heights be hopeless, yet is there

cloud subsequently passed, but who died at a green old age, in his 85th year, but unmarried, on the 20th of March, 1727.

The relations of Sir Isaac, who inherited his personal estate, devoted the sum of £500 to the erection of a monument to his memory in Westminister Abbey, but in his case the proverb that a prophet is honored everywhere save in his own country and among his own people, has, until recently, been verified. Some three or four years ago, however, the inhabitants, or the Town Council, of Grantham, bethought themselves that some ornament was required for a vacant space of ground which is styled St. Peter's Hill, though it seems to be little, if at all, above the dead level of the Lincolnshire fens. It was suggested, and the suggestion was favorably received, that the most appropriate ornament would be a monument to the memory of a man whose early career was so closely identified with the town and neighborhood, and whose researches had conferred an eternal benefit upon mankind. A committee was formed to carry out this object, and Mr. Thomas Winter, a member of the Town Council—to whose untiring zeal and energy its successful accomplishment is, we believe, mainly attributable—undertook to act as the honorary secretary. Mr. Winter at once placed himself in communication with Lord Rosse, Lord Brougham and other gentlemen of distinction in the literary and scientific world, who evinced a warm interest in the success of the scheme. Under these auspices the project received the sanction of the Royal Society, and the patronage of Her Majesty and the Prince Consort, who aided the fund by a subscription of £100. A general meeting of the subscribers was held in 1854, at St. George's Hall, Liverpool, during the *séance* in that town of the British Association for the Advancement of Science, when it was resolved that the memorial should be a bronze statue, and its execution was intrusted by the Committee of Selection to Mr. William Theed, the result of whose labors is not only creditable to himself, but not unworthy of the great philosopher whose memory it perpetuates. A detailed description of the statue appeared in the *Times* of Thursday last. The likeness of Sir Isaac is copied from the mask of his face taken after death, and from a portrait bust by Roubilliac. It represents him in the costume of the period, and in the gown of a Master of Arts, in the act of lecturing. The figure is nearly thirteen feet high, weighing upwards of two tons, and about half the quantity of the material of which it is composed was presented in the shape of old gun metal, by Her Majesty's government. The statue was cast at the foundery of Messrs. Robinson and Cottam, of Pimlico, and as a specimen of clean casting, with sharp outline, does them high credit. The figure stands upon a pedestal of Anglesey marble, designed by Mr. Theed, and cut by Mr. Rogers, of Park Hill. The total height of the pedestal and figure is twenty-seven feet, and its cost is £1,630, of which £600 were contributed by the inhabitants of Grantham and the neighborhood.

some use and much gratification in contemplating by what steps he ascended. Tracing his course of action may help others to gain the lower eminences lying within their reach, while admiration excited and curiosity satisfied are frames of mind both wholesome and pleasing. Nothing new, it is true, can be given in narrative, hardly anything in reflection, less still perhaps in comment or illustration; but it is well to assemble in one view various parts of the vast subject, with the surrounding circumstances, whether accidental or intrinsic, and to mark in passing the misconceptions raised by individual ignorance or national prejudice, which the historian of science occasionally finds crossing his path. The remark is common and is obvious, that the genius of Newton did not manifest itself at a very early age. His faculties were not, like those of some great and many ordinary individuals, precociously developed. Among the former, Clairaut stands preëminent, who at nineteen years of age presented to the Royal Academy a memoir of great originality upon a difficult subject in the higher geometry, and at eighteen published his great work on curves of double curvature, composed during the two preceding years. Pascal, too, at sixteen, wrote an excellent treatise on conic sections. That Newton cannot be ranked in this respect with those extraordinary persons is owing to the accidents which prevented him from entering upon mathematical study before his eighteenth year; and then a much greater marvel was wrought than even the Clairauts and the Pascals displayed.

His earliest history is involved in some obscurity, and the most celebrated of men has, in this particular, been compared to the most celebrated of rivers (the Nile), as if the course of both in its feebler state had been concealed from mortal eyes. We have it, however, well ascertained that within four years, between the ages of eighteen and twenty-two, he had begun to study mathematical science, and had taken his place among its greatest masters; learnt for the first time the elements of geometry and analysis, and discovered a calculus which entirely changed the face of the science, effecting a complete revolution in that and in every branch of philosophy connected with it. Before 1661 he had not read *Euclid;* in 1665 he had committed to writing the method of fluxions. At twenty-five years of age he had discovered the law of gravitation, and laid the foundation of celestial dynamics, the science created by him. Before ten years had elapsed he added to his discoveries that of the fundamental properties of light. So brilliant a course of discovery in so short a time, changing and reconstructing analytical, astronomical, and optical science, almost defies belief. The statement could only be deemed possible by an appeal to the incontestible evidence that proves it strictly true. By a rare felicity these

ctrines gained the universal assent of mankind as soon as they re clearly understood; and their originality has never been iously called in question.

Some doubts having been raised respecting his inventing the culus—doubts raised in consequence of his so long withhold- ; the publication of his method—no sooner was the inquiry tituted than the evidence produced proved so decisive that all n in all countries acknowledged him to have been by several urs the earliest inventor, and Leibnitz at the utmost, the first blisher, the only question raised being, first, whether or not had borrowed from Newton; and next, whether, as second ventor he could have any merit at all,—both which questions re long since been decided in favor of Leibnitz. But unde- ble though it be that Newton made the great steps of this ogress, and made them without any anticipation or participa- n by others, it is equally certain that there had been ap- aches in former times by preceding philosophers to the same coveries. Cavalieri, by his Geometry of Indivisibles (1635), berval, by his Method of Tangents (1367), had both given utions which Descartes could not attempt; and it is remarka- that Cavalieri regarded curves as polygons, surfaces as com- sed of lines, while Roberval viewed geometrical quantities as nerated by motion; so that the one approached to the differ- ial calculus, the other to fluxions; and Fermat, in the inter- l between them, comes still nearer the great discovery by his ermination of *maxima* and *minima*, and his drawing of tan- nts. More recently Hudden had made public similar methods rented by Schœtin; and what is material, treating the subject ebraically, while those just now mentioned had rather dealt th it geometrically. It is thus easy to perceive how near an proach had been made to the calculus before the great event its final discovery. There had in like manner been ap- oaches made to the law of gravitation, and the dynamical sys- n of the universe. Galileo's important propositions on motion, pecially on the curvilinear motion, and Kepler's laws upon the iptical form of the planetary orbits, the proportion of the eas to the times, and of the periodic times to the mean distan- s; and Huygens's theorems on centrifugal forces had been fol- wed by still nearer approaches to the doctrine of attraction. orelli had distinctly ascribed the motion of the satellites to eir being drawn towards the principal planets, and thus pre- nted from flying off by the centrifugal force. Even the com- sition of white light, and the different action of bodies upon component parts had been vaguely conjectured by Ant. de ominis, Archbishop of Spalatro, at the beginning, and more recisely in the middle of the 17th century by Marcus (Kron- nd, of Prague,) unknown to Newton, who only refers to the

Archbishop's work; while the treatise of Huygens on light, Grimaldi's observation on colors by inflexion, as well as on the elongation of the image in the prismatic spectrum, had been brought to his attention, although much less near to his own great discovery than Marcus's experiment.

But all this only shows that the discoveries of Newton, great and rapid as were the steps by which they advanced our knowledge, yet obeyed the law of continuity, or rather of gradual progress, which governs all human approaches towards perfection. The limited nature of man's faculties precludes the possibility of his ever reaching at once the utmost excellence of which they are capable. Survey the whole circle of the sciences, and trace the history of our progress in each, you find this to be the universal rule. In chemical philosophy the dreams of the Alchemists prepared the way for the more rational, though erroneous, theory of Stahl; and it was by repeated improvements that his errors, so long prevalent, were at length exploded, giving place to the sound doctrine which is now established. The great discoveries of Black and Priestley, on heat and aeriform fluids had been preceded by the happy conjectures of Newton and the experiments of others. Nay, Voltaire had well nigh discovered both the absorption of heat, the constitution of the atmosphere, and the oxydation of metals; and by a few more trials might have ascertained it. Cuvier had been preceded by inquirers who took sound views of fossil osteology, among whom the truly original genius of Hunter fills the foremost place. The inductive system of Bacon had been, at least in its practice, known to his predecessors. Observations and even experiments were not unknown to the ancient philosophers, though mingled with gross errors; in early times, almost in the dark ages, experimental inquiries had been carried on with success by Friar Bacon, and that method actually recommended in a treatise, as it was two centuries later by Leonardo da Vinci, and at the latter end of the next century Gilbert examined the whole subject of magnetic action entirely by experiments. So that Lord Bacon's claim to be regarded as the father of modern philosophy rests upon the important, the invaluable step of reducing to a system the method of investigation adopted by those eminent men, generalizing it, and extending its application to all matters of contingent truth, exploding the errors, the absurd dogmas, and fantastic subtleties of the ancient schools, and above all, confining to the subject of our inquiry, and the manner of conducting it, within the limits which our faculties prescribe. Nor is this great law of gradual progress confined to the physical sciences; in the moral it equally governs. Before the foundations of political economy were laid by Hume and Smith, a great step had been made by the French philosophers, disciples of

Quesnai; but a nearer approach to sound principles had signalized the labors of Gournay, and those labors had been shared and his doctrines patronized by Turgôt when Chief Minister. Again, in constitutional policy, see by what slow degrees, from its first rude elements, the attendance of feudal tenants at their lord's court, and the summons of burghers to grant supplies of money, the great discovery of modern times in the science of practical politics has been effected, the representative scheme which enables states of any extent to enjoy popular government and allows mixed monarchy to be established, combining freedom with order—a plan pronounced by the statesmen and writers of antiquity to be of hardly possible formation, and wholly impossible continuance. The globe itself, as well as the science of its inhabitants, has been explored according to the law which forbids a sudden and rapid leaping forward, and decrees that each successive step, prepared by the last, shall facilitate the next. Even Columbus followed several successful discoverers on a smaller scale, and is by some believed to have had, unknown to him, a predecessor in the great exploit by which he pierced the night of ages, and unfolded a new world to the eyes of the old. The arts afford no exception to the general law. Demosthenes had eminent forerunners, Pericles the last of them. Homer must have had predecessors of great merit, though doubtless as far surpassed by him as Fra Bartolomeo and Pietro Perugino were by Michael Angelo and Raphael. Dante owed much to Virgil; he may be allowed to have owed, through his Latin Mentor, not a little to the old Grecian; and Milton had both the orators and the poets of the ancient world for his predecessors and his masters. The art of war itself is no exception to the rule. The plan of bringing an overpowering force to bear on a given point had been tried occasionally before Frederick II. reduced it to a system; and the Wellingtons and Napoleons of our own day made it the foundation of their strategy as it had also been previously the main-spring of our naval tactics.

It has oftentimes been held that the invention of logarithms stands alone in the history of science, as having been preceded by no step leading towards the discovery. There is, however, great inaccuracy in this statement, for not only was the doctrine of infinitesimals familiar to its illustrious author, and the relation of geometrical to arithmetical series well known, but he had himself struck out several methods of great ingenuity and utility (as that known by the name of Napier's Bones)—methods that are now forgotten, eclipsed as they were by the consummation which has immortalized his name. So the inventive powers of Watt, preceded as he was by Worcester and Newcomen, but far more materially by Causs and Papin, had been exercised on

some admirable contrivances, now forgotten, before he made the step which created the steam-engine anew—not only the parallel motion, possibly a corollary to the proposition on circular motion in the *Principia*, but the separate condensation, and above all, the governor, perhaps the most exquisite of mechanical inventions; and now we have those here present who apply the like principle to the diffusion of knowledge, aware, as they must be, that its expansion has the same happy effect, naturally preventing mischief from its excess which the skill of the great mechanist gave artificially to steam, thus rendering his engine as safe as it is powerful.

The grand difference, then, between one discovery or invention and another is in degree rather than in kind; the degree in which a person, while he outstrips those whom he comes after, also lives, as it were, before his age. Nor can any doubt exist that, in this respect, Newton stands at the head of all who have extended the bounds of knowledge. The sciences of dynamics and of optics are especially to be regarded in this point of view, but the former in particular; and the completeness of the system which he unfolded, its having been at the first elaborated and given in perfection, its having, however new, stood the test of time, and survived, nay gained by, the most rigorous scrutiny, can be predicated of this system alone, at least in its high degree. That the calculus, and those parts of dynamics which are purely mathematical, should thus endure for ever is a matter of course. But his system of the universe rests partly upon contingent truths, and might have yielded to new experiments and more extended observation. Nay, at times it has been thought to fail, and further investigation was deemed requisite to ascertain if any error had been introduced—if any circumstance had escaped the notice of the great founder. The most memorable instance of this kind is the discrepancy supposed to have been found between the theory and the fact in the motion of the lunar apsides, which about the middle of the last century occupied the three first analysts of the age. The error was discovered by themselves to have been their own in the process of their investigation; and this, like all the other doubts that were ever momentarily entertained, only led in each instance to new and more brilliant triumphs of the system. The prodigious superiority in this cardinal point of the Newtonian to other discoveries, appears manifest upon examining almost any of the chapters in the history of science. Successive improvements have, by extending our views, constantly displaced the system that appeared firmly established. To take a familiar instance, how little remains of Lavoisier's doctrine of combustion and acidification, except the negative positions, the subversion of the system of Stahl! The substance having most eminently the prop-

rties of an acid (chlorine) is found to have no oxygen at all, while many substances abounding in oxygen, including alkalies themselves, have no acid property whatever; and without the access of oxygenous or of any other gas heat and flame are produced in excess.

The doctrines of free trade had not long been promulgated by Smith before Bentham demonstrated that his exception of usury was groundless; and his theory has been repeatedly proved erroneous on colonial establishments, as well as his exception to it on the navigation laws; and the imperfection of his views on the nature of rent is undeniable, as well as on the principle of population. In these and such instances as these it would not be easy to find in the original doctrines the means of correcting subsequent errors, or the germs of extended discovery. But even if philosophers finally adopt the undulatory theory of light instead of the atomic, it must be borne in mind that Newton gave the first elements of it by the well known proposition in the 8th section of the Second Book of the *Principia*, the scholium to that section also indicating his expectation that it would be applied to optical science; while Biot has shown how the doctrine of fits of reflection and transmission tallies with polarization, if not with undulation also.

But the most marvellous attribute of Newton's discoveries, that in which they stand out prominent among all the other feats of scientific research, stamped with the peculiarity of his intellectual character—is this, that their great author lived before his age, anticipating in part what was long after wholly accomplished, and thus unfolding some things which at the time could be but imperfectly, others, not at all, comprehended, and not rarely pointing out the path and affording the means of treading it to the ascertainment of truths then veiled in darkness. He not only enlarged the actual dominion of knowledge, penetrating to regions never before explored, and taking with a firm hand undisputed possession; but he showed how the bounds of the visible horizon might be yet further extended, and enabled his successors to occupy what he could only descry; as the illustrious discoverer of the new world made the inhabitants of the old cast their eyes over lands and seas far distant from those he had traversed; lands and seas of which they could form to themselves no conception, any more than they had been able to comprehend the course by which he led them on his grand enterprise. In this achievement, and in the qualities which alone made it possible, inexhaustible fertility of resources, patience unsubdued, close meditation that would suffer no distraction, steady determination to pursue paths that seemed all but hopeless, and unflinching courage to declare the truths they led to, how far soever removed from ordinary apprehension—in

these characteristics of high and original genius we may be permitted to compare the career of those great men. But Columbus did not invent the mariner's compass as Newton did the instrument which guided his course and enabled him to make his discoveries, and his successors to extend them by closely following his directions in using it. Nor did the compass suffice to the great navigator without making any observations, though he dared to steer without a chart; while it is certain that by the philosopher's instrument his discoveries were extended over the whole system of the universe, determining the masses, the forms, and the motions of all its parts by the mere inspection of abstract calculations and formulas analytically deduced. The two great improvements in this instrument which have been made—the calculus of variations by Euler and Lagrange, the method of partial differences by d'Alembert—we have every reason to believe were known at least in part to Newton himself. His having solved an isoperimetrical problem (finding the line whose revolution forms the solid of least resistance,) shows clearly that he must have made the coordinates of the generating curve vary, and his construction agrees exactly with the equation given by that calculus. That he must have tried the process of integrating by parts in attempting to generalize the inverse problem of central forces before he had recourse to the geometrical approximation which he has given, and also when he sought the means of ascertaining the comet's path, which he has termed by far the most difficult of problems, is eminently probable, when we consider how naturally that method flows from the ordinary process for differentiating compound quantities, by supposing each variable in succession constant; in short, differentiating by parts. As to the calculus of variations having substantially been known to him no doubt can be entertained. Again: in estimating the ellipticity of the earth, he proceeded upon the assumption of a proposition, of which he gave no demonstration, (any more than he had done of the isoperimetrical problem,) that the ratio of the centrifugal force to gravitation determines the ellipticity.

Half a century later, that which no one before knew to be true, which many probably considered to be erroneous, was examined by one of his most distinguished followers, Maclaurin, and demonstrated most satisfactorily to be true. Newton had not failed to perceive the necessary effects of gravitation in producing other phenomena beside the regular motion of the planets and their satellites in their course round their several centres of attraction. One of these phenomena, wholly unsuspected before the discovery of the general law, is the alternate movement to and fro of the earth's axis, in consequence of the solar (and also of the lunar) attraction combined with the earth's motion. This

.tion, or nutation, distinctly announced by him as the result ie theory, was not found by actual observation to exist till r years and upwards had elapsed, when Bradley proved the The great discoveries which have been made by Lagrange Laplace upon the results of disturbing forces have established law of periodical variation of orbits, which secures the ility of the system by prescribing a *maximum* and a *mini-* amount of deviation; and this is not a contingent, but a ssary truth, by rigorous demonstration, the inevitable result adoubted *data* in point of fact, the eccentricities of the orbits, lirections of the motions, and the movement in one plane of tain position. That wonderful proposition of Newton, which, . its corollaries, may be said to give the whole doctrine of irbing forces, has been little more than applied and extended he labors of succeeding geometricians. Indeed, La Place, k with wonder at one of his comprehensive general state-ts on disturbing forces in another proposition, has not hesita-o assert that it contains the germ of Lagrange's celebrated in-y exactly a century after the *Principia* was given to the world. he wonderful powers of generalization, combined with the ness of never shrinking from a conclusion that seemed the imate result of his investigations—how new and even start-soever it might appear—was strikingly shown in that orable inference which he drew from optical phenomena, the diamond is "an unctuous substance coagulated"; sub-ent discoveries having proved both that such substances are onaceous, and that the diamond is crystallized carbon; and oundations of mechanical chemistry were laid by him with oldest induction and most felicitous anticipations of what since been effected. The solution of the inverse problem of rbing forces has led Le Verrier and Adams to the discovery new planet, merely by deductions from the manner in which notions of an old one are affected, and its orbit has been so ulated that observers could find it—nay, its disc as measured them varies less than a second from the amount given he theory. Moreover, when Newton gave his estimate of earth's density, he wrote a century before Maskelyne, who, neasuring the force of gravitation in the Scotch mountains, the proportion to water as 4·716 to 1; and, many years , Cavendish, by experiments with mechanical apparatus, 8) corrected this to 5·48, and Baily, more recently (1842) to , Newton having given the proportion as between five and imes. In these instances he only showed the way and an-ated the result of future inquiry by his followers. But the le figure of the earth affords an example of the same kind, this difference, that here he has himself perfected the dis-ry and nearly completed the demonstration. From the

mutual gravitation of the particles which form its mass, combined with their motion round its axis, he deduced the proposition that it must be flattened at the poles; and he calculated the proportion of its polar to its equatorial diameter. By a most refined process he gave this proportion upon the supposition of the mass being homogeneous. That the proportion is different in consequence of the mass being heterogeneous does not in the least affect the soundness of his conclusion. Accurate measurements of a degree of latitude in the equatorial and polar regions, with experiments on the force of gravitation in those regions, by the different lengths of a pendulum vibrating seconds, have shown that the excess of the equatorial diameter is about 11 miles less than he had deduced it from the theory; and thus that the globe is not homogeneous. But on the assumption of a fluid mass, the ground of his hydrostatical investigation, his proportion of 229 to 230 remains unshaken, and is precisely the one adopted and reasoned from by Laplace, after all the improvements and all the discoveries of later times. Surely at this we may well stand amazed, if not awe-struck.

A century of study, of improvement, of discovery, has passed away, and we find Laplace master of all the new resources of the calculus, and occupying the heights to which the labors of Euler, Clairaut, D'Alembert and Lagrange have enabled us to ascend, adopting the Newtonian fraction of 1:230 as the accurate solution of this speculative problem. New admeasurements have been undertaken upon a vast scale, patronised by the munificence of rival governments; new experiments have been performed with approved apparatus of exquisite delicacy; new observations have been accumulated, with glasses far exceeding any powers possessed by the resources of optics in the days of him to whom the science of optics as well as dynamics owes its origin; the theory and the fact have thus been compared and reconciled together in more perfect harmony; but that theory has remained unimproved, and the great principle of gravitation, with its most sublime results, now stands in the attitude, and of the dimensions, and with the symmetry, which both the law and its application received at once from the mighty hand of its immortal author. But the contemplation of Newton's discoveries raises other feelings than wonder at his matchless genius. The light with which it shines is not more dazzling than useful. The difficulties of his course and his expedients, alike copious and refined for surmounting them, exercise the faculties of the wise while commanding their admiration. But the results of his investigations, often abstruse, are truths so grand and comprehensive, yet so plain, that they both captivate and instruct the simple. The gratitude, too, which they inspire, and the veneration with which they encircle his name, far from tending to obstruct future improvement, only proclaim his disciples the

zealous because rational followers of one whose example both encouraged and enabled his successors to make further progress. How unlike the blind devotion to a master which for so many ages of the modern world paralysed the energies of the human mind!—

> "Had we still paid that homage to a name
> Which only God and Nature justly claim,
> The western seas had been our utmost bound,
> The poets still might dream the sun was drown'd,
> And all the stars that shine in southern skies
> Had been admired by none but savage eyes."

Nor let it be imagined that the feelings of wonder excited by contemplating the achievements of this great man are in any degree whatever the result of national partiality, and confined to the country which glories in having given him birth. The language which expresses her veneration is equalled, perhaps exceeded, by that in which other nations give utterance to theirs; not merely by the general voice, but by the well-considered and well-informed judgment of the masters of science. Leibnitz, when asked at the royal table in Berlin his opinion of Newton, said that, "taking mathematicians from the beginning of the world to the time when Newton lived, what he had done was much the better half." "The *Principia* will ever remain a monument of the profound genius which revealed to us the greatest law of the universe," are the words of Laplace. "That work stands preëminent above all the other productions of the human mind." "The discovery of that simple and general law, by the greatness and the variety of the objects which it embraces, confers honor upon the intellect of man." Lagrange, we are told by D'Alembert, was wont to describe Newton as the greatest genius that ever existed, but to add "how fortunate he was also, because there can only once be found a system of the universe to establish." "Never," says the father of the Institute of France—one filling a high place among the most eminent of its members—"Never," says M. Biot, "was the supremacy of intellect so justly established and so fully confessed. In mathematical and in experimental science without an equal and without an example, combining the genius for both in its highest degree." The *Principia* he terms the greatest work ever produced by the mind of man, adding, in the words of Halley, "that a nearer approach to the Divine nature has not been permitted to mortals." "In first giving to the world Newton's method of fluxions," says Fontenelle, "Leibnitz did like Prometheus—he stole fire from Heaven to bestow it upon men." "Does Newton," L'Hôpital asked, "sleep and wake like other men? I figure him to myself as a celestial genius, entirely disengaged from matter."

To so renowned a benefactor of the world, thus exalted to the loftiest place by the common consent of all men—one whose life,

without the intermission of an hour, was passed in the search after truths the most important, and at whose hands the human race had received only good, never evil—it is befitting that no memorial should have been raised by nations which erect statues to the tyrants and conquerors, the scourges of mankind. * * * * But that his own countrymen justly proud of having lived in his time, should have left this duty to their successors, after a century and a half of professed veneration and lip homage, may well be deemed strange. The inscription upon the cathedral, masterpiece of his celebrated friend's architecture, may possibly be applied in defence of this neglect: "If you seek for a monument, look around." "If you seek for a monument, lift up your eyes to the heavens, which show forth his fame." Nor, when we recollect the Greek orator's exclamation, "The whole earth is the monument of illustrious men," can we stop short of declaring that the whole universe is Newton's. Yet in raising the statue which preserves his likeness, near the place of his birth, on the spot where his prodigious faculties were unfolded and trained, we at once gratify our honest pride as citizens of the same state, and humbly testify our grateful sense of the Divine goodness which deigned to bestow upon our race one so marvellously gifted to comprehend the works of Infinite Wisdom, and so piously resolved to make all his study of them the source of religious contemplations, both philosophical and sublime.

ART. IX.—*Description of a new Mineral Species from Chili;* by FREDERICK FIELD. (From a letter to J. D. DANA, dated Guyacana, Coquimbo, Chili, September 6, 1858).

I SEND you a specimen of a mineral from the Cordilleras of Chili, which appears to me highly interesting. It consists entirely of copper, arsenic and sulphur, having the following composition:

Copper,	48·50
Sulphur,	31·82
Arsenic,	19·14
Iron, silver,	*traces.*
	99·46

and consequently has the following formula: $3Cu_2S+AsS_5$, and may be considered as a tribasic sulpharseniate of copper, like the artificial tribasic sulpharseniate of potassium, in which that metal is replaced by Cu_2. Hardness 3·5—4. Sp. gr. 4·39.

You will see it resembles Tennantite in which the arsenic takes the place of the iron; a specimen of Tennantite having the following value: Cu 48·2, As 12·5, Fe 9·0, S 31·14. I have proposed the name "*Guayacanite*" for this new species, as the mineral was first brought to the large copper smelting works of *Guayacana.*

Art. X.—*Geographical Notices.* No. V.

Recent Surveys of the Amoor River.—The opening of the Chinese Empire, the negotiation of a commercial treaty with Japan, and the spread of the Russian dominion over the Amoor region and Manchooria, in respect to which intelligence has recently been received, are events which combine to give peculiar interest and importance to our meagre knowledge of Eastern Asia.

The proceedings in China and Japan have attracted universal attention. The advances of Russia, however, in developing the resources of its legitimate territory and in acquiring new domains, have been conducted in a manner so quiet as to escape general attention and elude the opposition of diplomatic vigilance. Siberia has been so little known, and so much depreciated by the world at large, that the accession of some thousands of square miles to its territory has passed almost unnoticed. But it will not be many years before the Russian policy on the Amoor river will be appreciated as it deserves, and already the demand has become urgent in this country for definite knowledge in respect to a region with which American relations are likely to grow continually more intimate.

To satisfy in part such inquiries, the Government at Washington has lately published (Wash. 67 pp., 8vo) a "Report of Explorations on the Amoor river," which were made last year by Mr. P. McD. Collins, an American citizen, who received from the President, in 1856, an appointment, without a post, as "United States Commercial Agent for the Amoor river," and who travelled over land from the Baltic to the Pacific, endeavoring to ascertain what relations might be established with advantage between our own country and the possessions of Russia in Eastern Asia.

The official rank of Mr. Collins gave him opportunities of intercourse with Gen. Mouravieff, the Governor of Eastern Siberia, and with many other dignitaries, from whom he gathered some important facts in respect to the Russian policy in that region. In addition to these, he states his own observations made on a hurried tour through a region of vast extent and varied resources. His report accordingly will be valuable to those who are interested in political changes, and to American merchants, but the circumstances under which it was prepared were by no means favorable to the collection of scientific materials. Three hastily constructed maps, (without the indications of latitude and longitude,) appended to the volume, add almost nothing to our knowledge.

Mr. Collins crossed the Urals at Ecatherinberg, and then proceeded by Tumen, Omsk and Tomsk to Irkootsk, where he remained a month. He then visited Kyatcha and Mai-mat-tschin, neighboring towns,—the former Russian, the latter Chinese,—in which the chief exchanges of the two empires are effected. After returning to Irkootsk, he went on to Chetah, visited the celebrated mines of Nerchinsk and then proceeded to Chilkah, from which place, in a small row-boat, with two or three companions, beside a crew of five men, he followed the Amoor to its mouth. This river voyage of about 2600 miles he made in fifty two days.

The impressions of Mr. Collins are favorable in every respect to the introduction of American commerce. The river is said to be navigable by steamboats from the junction of the Schilka and Argoon to its mouth. The neighboring country is thickly settled, various articles of export, especially furs and hides, are abundant, and manufactured goods are in demand. Many of Mr. Collins's incidental remarks in respect to agriculture and mining are of an interesting character, but his report must be looked at as a collection of "Observations" rather than as the result of "Explorations." Coming as it does from an American it may serve to draw attention to the much more elaborate and satisfactory investigations which have been conducted during the last few years under the direction of the Russian government.

Before proceeding to enumerate the more important of these expeditions and their several characteristics we stop to inquire the occasion of the impulse lately given to Siberian explorations.

The immense capacity of Russia for producing raw materials has long demanded freer communication between the interior and the coast, both in the east and in the west, than has hitherto been enjoyed. The complete control by the Czar of the Amoor river would have almost as much influence on the development of Siberian resources as the control of the Dardanelles on the prosperity of Russia proper. Let the navigation of the stream be made easy, and a few lines of railway established, and the empire of Russia will be as open as any country to the trade of China, Japan, the East Indies and America.

Taking advantage of the unsettled condition of the country around the Amoor, Russia has been for some years quietly pushing her out-posts farther and farther into the proper dominions of China. Precisely what has been her progress and what are now the claims of her "manifest destiny," can only be learned in the cabinet of St. Petersburg. This much is evident. By the treaty of Russia with China in 1689,* after the well known defeat

* Cf. Petermann on the Amur Stream. Geogr. Mittheil, 1856. p. 472.

, Albasin, and also by the treaty of 1727, the boundary be- veen the two empires was the Northern watershed of the ιmoor river on the Stanovoi mountains, leaving the entire basin f the river, east of the junction of the Schilka and Argoon in ossession of the Chinese. It was so delineated on the official harts of Russia. In 1844–5, von Middendorf, under instruc- ons from the Imp. Acad. of Sciences in St. Petersburgh, pro- eeded to determine on the spot the exact boundary line. He eported that the Chinese did not claim as far north as the atershed, but only as far on the left bank of the Amoor as the ibutaries were navigable for small boats. Without further eremony, so far as it appears, some fifty thousand square versts n the south of the Stanovoi summits were accordingly indi- ated on the charts as belonging to Russian dominion.

The Crimean war caused the removal of large bodies of troops, ften under highly intelligent officers, quite to the Pacific coast, r the defence of such Russian possessions as were threatened y the allied fleets. About that time not less than five Russian rts were "provisionally" established on the Amoor, between Ist-Strelotschnaja and the mouth of the Sungari. Nicolaieff, t the mouth of the Amoor river, was fortified, and even so far outh (on the right bank of the Amoor) as De Castries bay the ussian flag was raised and a fort erected. The actual posses- ion of the Amoor was thus completed. By recent advices it ppears that Russia, in addition to a commercial treaty like that f the other powers, has obtained a treaty conceding to it all of ie Amoor territory which had thus been occupied. What are ie exact limits of this concession we are not yet informed.

There can be no question that Russia will employ to its own dvantage the aggrandizements thus made, but whether its next dvances will be in China, or Japan or the English possessions ı India the future will reveal. It will not be forgotten that ussia was the first power which watched the movements of om. Perry in Japan, nor on the other hand that Japan has long een suspicious of its Muscovite neighbor, having even dis- atched a special agent to the Amoor river to discover if possible he ulterior purpose of the movements in that region.*

The considerations which we have now presented sufficiently xplain the recent energy which Russia has displayed in the ex- plorations of the Amoor. So many scientific investigators have now visited that country that we may anticipate at an early day vast accessions to our knowledge of Eastern Asia. Already the outlines which have been communicated to the world, and which may be found for the most part in the comprehensive "Mittheil- ungen" of Dr. Petermann, are sufficient to awaken a profound

* Perry's Japan. i. 32.

interest. * It would not be difficult to compile from them a far more reliable and complete report of the Amoor country than could be derived from the observations of many non-scientific travellers.

We proceed to specify some of the accounts of the Russian explorations.

1. We mention first a Report of Peschtschuroff, who accompanied Count Putiatin around Cape Horn to Japan and afterward returned by way of Irkootsk to St. Petersburgh. His astronomical determinations of twenty-three points on the River Amoor, between its mouth and its commencement were published two years ago. More recently he has furnished a hydrographic description of the upper portion of the river from Ust-Strelotschnaja to the mouth of the Sungari, with some general statements in respect to the characteristics of the whole stream and many interesting ethnographical remarks. He refers in this report to a special chart of the Amoor in twelve sheets on a scale of two miles to an English inch (about 1:146000) which has been constructed from the sketches of Lieut. Popoff. Dr. Petermann publishes what he supposes to be a reduction of this chart, adding however some corrections obviously demanded by Peschtschuroff's data. The observations now making by Lieut. Roskoff may be expected to give still further accuracy to these delineations. The fact is not concealed that there are obstructions to navigation, especially numerous islands.

2. Herr Permikin has reported to the Imp. Geograph. Society of Russia in respect to the Geology and Natural History of the entire stream. Between the Sungari and the mouth of the Amoor, his journal may be considered in its general statements as supplemental to that of Peschtschuroff.

3. Leopold Schrenk's report to the Academy of Sciences gives an outline of his journey down and up the whole course of the Amoor. He has made important collections for scientific purposes. Thirty of his boxes containing specimens in Natural History, were at the date of recent advices on their way to St. Petersburgh. His investigations of the island Sachalen and his examination of the region around the mouth of the stream, and as far up as the Ussuri are particularly extended.

4. Since 1855, the Imperial Geographical Society of Russia has sustained a party of explorers known as the "East Siberian Expedition" under the direction of the astronomer Schwarz. Its

* The more important of these articles, extending through four volumes of the Mittheilungen (Gotha, 1855–8), are the following:—

1856, p. 175. Latest Russian Acquisitions in the Chinese Territory; by Dr. Petermann. p. 472. Peschtschuroff's Surveys on the Amoor; by the same. 1857, p. 296. The Amoor Stream; by the same. p. 518. L. Schrenk's Latest Researches. 1858, p. 70. Maximowitsch's Researches on the Amoor.

original design was to survey in three years Trans Baikal, and the district between the upper Lena and the Wittim. But the investigations having extended on one side to the Amoor and having been impeded on the other, the party was to continue in the field during 1858. Notices of the progress of the expedition by Dr. Schirren have been printed from time to time in the Berlin "Zeitschrift für allgemeine Erdkunde." The May number of that journal contains a brief summary of the labors of each member of the party during the last three years. Lieut. Roshkoff has been especially charged with the Amoor survey. Radde has been making Natural History investigations in part of its neighborhood.

Roshkoff determined the position of twenty-one places and surveyed the route from Ust-Strelotschnaja to Albasin and from Marien station to Nicolaieff, and the part of the river between his surveys were surveyed by Lieut. Sondhagen.

5. Around the mouth of the Amoor river, and for a considerable distance upon the coast to the North and South, the Russian flotilla has collected much information of importance in navigation. Some of these details are given in the report of the Russian Admirals Sawojka and Putiatin in respect to the naval operations in the straits of Tartary, in 1855, which is published in the official journal of the Ministry of the Marine.

The English cruisers made at the same period soundings and observations, especially around the island of Sachalen, many of which are given in Whitingham's Notes on the late expedition against the Russian Siberia Settlements. (Lond. 1856.)

6. The last investigations to which we call attention are those of Maximowitsch, who has been travelling for the Imperial Botanical Garden of St. Petersburgh. His letters have been published in the bulletin of that establishment, and many of the plants which he collected described by Ruprecht. Maximowitsch travelled part of the time with Schrenk, and part of the time independently.

From this brief indication of the explorations which have lately been made under the patronage or direction of the Russian government, it is evident that we may look for vast accessions at an early day to our knowledge of the Amoor country. All its characteristics have been so little known heretofore, that much has now been unquestionably gained in different departments of natural science. The commercial world will not be long in appropriating the important results of these various investigations.

New Maps of Tropical America.—The German publishers have recently issued three important maps of different parts of Tropical America based upon recent surveys and authentic travels.

The most complete of these charts is Kiepert's "New Map of Central America," published in four sheets, Berlin, Reimer. It includes the territory between 76° and 79° long. west from Greenwich, and between 6° and 22° N. lat. Although immense districts within these limits are unexplored, this map will be found of very great value, as an accurate presentation of what is known. The scale is 1 : 2,000,000. Upon it, there are five subordinate maps. 1. The state of San Salvador, and the proposed Honduras Rail Road from the surveys of E. G. Squier and W. H. Jeffers, in 1853. Scale, 1 : 1,000,000. 2. The isthmus of Tehuantepec as surveyed for a proposed railway, in 1851, by Col. Barnard. Scale 1 : 1,000,000. 3. The river San Juan de Nicaragua, from the survey in 1847, published in 1851 by A. von Bulow. Scale 1 : 500,000. 4. Isthmus and Rail Road of Panama, from the surveys in 1849 by Col. C. W. Hughes. Scale 1 : 400,000. Tract of the proposed Inter-oceanic Canal of the river Atrato, from the surveys of W. Kennish in 1854. Scale 1 : 400,000.

In reference to the materials used in constructing this map, the following note is given by the compiler.

"The coast lines are copied from the British Admiralty charts, surveyed on the Atlantic side principally by Capt. Owen, on the Pacific side from New Granada westward to Point Herradura in Costarica by Capt. Kellett. The part not yet entirely surveyed by the British Navy, from that point to the Isthmus of Tehuantepec has been retained from the old Spanish charts, with some corrections in the principal bays and harbors, made by British French and American seamen.

"Of the interior no part has hitherto been satisfactorily surveyed, with the only exception of the measurements executed for the proposed canal and railroad lines and their next environs on the isthmuses of Tehuantepec, Comayagua, Lake Nicaragua and Panama, specified with the names of the authors on the cartons accompanying this map. The other parts of the map on whose accuracy most confidence may be placed are the following: 1, the part of the New Granadian territory east of the 80th degree, reduced from a map compiled with the aid of old Spanish documents, and corrected by some new surveys by Col. Augustino Codazzi, (published in Berlin, 1857); 2, the central or cultivated part of the state of Costarica, taken from a MSS. map by Mr. Alexander von Bülow; 3, the greater part of the states S. Salvador, Honduras and Nicaragua, copied after the surveys executed in 1851–53 by Messrs. Squier, Jeffers and Hitchcock; 4, the northern part of Yucatan, from a Spanish map, corrected by personal observation and published by Mr. Heller, an Austrian naturalist in 1848.

"To the same gentleman we are indebted for the new intelli-nce produced on the southern part of the state of Tabasco. ll available works of other distinguished travellers (viz. Messrs. hompson in 1825, Dunn 1827, Legh Page 1834, Montgomery 338, Stephens 1838–39, Dunlop 1844–46, Wagner and Scherzer 353–54, and others,) have been consulted in order to correct nd to complete the other parts of the map, especially the state f Guatemala the rest of the detail being taken with the neces-ary precaution in the drawing of the mountains, from the well nown but not entirely authentic map of Mr. Baily."

A second chart in two sheets, covering part of the territory ncluded in the map just mentioned, has also been published by leimer. It is entitled "Carte de l'Isthme de Panama et de Darien, et de la province de Choco." It is based on the surveys of Augustin Codazzi, Colonel in the New Granada corps of Engineers, and is edited by Dr. Kiepert. It is printed on two sheets, on a scale of 1:800,000. Subordinate maps (correspond-ng with those above mentioned) of the routes of the Panama Rail Road and the proposed Atrate canal are also given. In the outlines of the coast, Mr. Codazzi has based his chart on the surveys of the English engineer, Mr. Kellet, published in 1854, with the introduction, however, of some changes. Dr. Kiepert, who is conscientiously exact in all his publications, is forced in a note which accompanies this map, to express his doubts as to the reliability of the delineations of the interior of the country.

A third map, recently issued by the same editor and pub-lisher, is entitled "Tropical America North of the Equator," and comprises the West Indies, Central America, Mexico, New Granada, and Venezuela. It is composed with the help of all cartographic and literary materials hitherto published. One of the sheets contains a subordinate map of the central part of the Mexican Republic on an enlarged scale. The entire work is executed with great clearness and precision.

Recent Explorations in South Australia.—We condense from the Berlin "Zeitschrift für allgemeine Erdkunde" for Au-gust, 1858, the following interesting notice of late explorations in South Australia. In the year 1857 two explorations were made under the auspices of the Colonial government into the northern part of the mountainous region which extends from Spencer Gulf north-easterly and nearly to the bottom of the vast curve formed by Lake Torrens. This singular lake, now supposed to consist of immense morasses, salt pools, and shallow expanses of fresh water—so shallow as to be dry during a portion of the year—appears to commence to the northward of Spencer Gulf, with which it is partially connected by a valley of towards 400 yards in length,) and, extending northerly three degrees, to sweep N.E., E., S.E., then southerly in 140 E. long. to a point

nearly opposite the place of commencing. The mountain land above alluded to, as enclosed by Lake Torrens, consists of the Flinders range, which runs in a nearly straight and unbroken line or belt from the vicinity of Port Augusta north-easterly to 30° 40′ S. lat., and of the Pound Range, etc., a series of detached peaks or spurs, appearing to branch off in all directions from the northern extremity of the Flinders Range. The main object of these explorations seems to have been to lay open new and desirable grazing lands, and thus to direct intelligently the course of colonization. Accordingly Goyder, who made the first exploration in May and June, especially noted vegetation, followed the course of streams, fixed the position of fresh-water springs or pools, and when he reached the south shore of the bend of Lake Torrens in 29° 13′ S. lat. joyfully reports it "as an apparently interminable body of *fresh* water flowing with a decided current towards the northwest." He describes the north shore, as seen through a telescope, as covered with vegetation, and yet he makes no mention of the depth, real or apparent, of the water. As we shall afterwards see, the government was misled into the conclusion that this portion of the lake was navigable, and that it might be made the highway to unexplored wealth in the heart of the continent. Nor was this the only point in which his report proved an unsafe guide. His glowing pictures of the fertility of large portions of the soil were based partly on near at hand observations during the most favorable period of the year when the streams were full, and partly also on bird's-eye views, from the summits of mountains, of wide reaches of landscape invested with the deceitful colors of the *mirage*.

Freeling's expedition, undertaken in consequence of Goyder's report, and in the following September, was chiefly directed to the navigation of Lake Torrens from the point where Goyder had observed it "flowing in a northwesterly direction." For this purpose he was provided with a small iron boat. On his arrival at the above named point, Freeling to his surprise found the water to have receded more than half a mile. The soil thus laid bare was "clay, mixed with sand, without stones;" so too the shore for a mile inland, bore the same character, but arid and cracked into fissures by the heat of the sun. From the very slight elevation of the shore, which bore the appearance of sandy flats, as well as from drift-wood and water-marks, it seemed probable that the lake had already receded some six miles, even at the time of Goyder's visit. Freeling was at once convinced that the lake was not navigable, but he resolved not to return until baffled by actual experiment. He accordingly made three successive attempts to reach deep water. On the preliminary trial he waded but a short distance out, sank ankle-deep in mud

flowed with water only one inch deep. He then had the brought, and this, though on other occasions a light burden wo men, was now, in consequence of the mud, carried with ulty by six, one quarter of a mile, where finding only two es of water, they returned. The final experiment was ex-ely dangerous. The party waded knee-deep through viscid tenacious mud, three miles from the shore, and found but nches of water. They were much fatigued with the labor, under constant apprehension at every step of sinking in treacherous quagmire, and were rejoiced at their "good ne in coming upon two small islands, raised but little above eneral level, where they rested before retracing their course." of the party, however, more courageous than the rest, ed on for the north shore, thinking to wade across the lake. r hardihood had nearly proved fatal, for after accomplishing t two miles farther, they became so exhausted, that it was by the utmost labor that they were enabled to rejoin their ades. They reported the water somewhat deeper and the slightly more yielding. Thus ended the expectations of overnment in that quarter. Freeling pronounces the ap-ance of the lake, its islands, and the opposite shore as seen oyder to be due to the *mirage*.

e expedition of Stephen Hack in the summer of 1857 from ky Bay to Lake Gairdner and its vicinity, has proved of reater practical importance than either of the two already ed. "The new grazing lands discovered to the south of Gairdner comprise an area of more than 4,500 square s." Hack skirted the south shore of this great lake, but for ous sufficient reasons he was obliged to discontinue his ex-tions, and he returned across the country to Port Augusta. Harris, surveyor to the expedition, took by azimuth obser-ns, combined with determinations of latitude, the position of ermanent bodies of fresh water, and of the mountains d on the route, and charted the outlines of the lake-shore he results of trigonometrical measurements. Mr. Hack's nal intention was to have rounded the sourthernmost bay of Gairdner and ascertained its entire outlines upon the east. hinks there is reason to suspect some union between Lake ens and Lake Gairdner, and perhaps that they are one and same great expanse. It is hinted that the geographical s of this expedition are of great interest and importance, they have not yet come to hand. Meanwhile we may judge e pressing need in South Australia of more extended pas-ge, by the fact that within one week after Mr. Hack's return, tiations were pending for the purchase of about 2000 of the 0 square miles of meadow land newly discovered by him. l shortly previous to this, one of the largest proprietors had

been compelled to send a herd of his cattle to New South Wales to graze.

An expedition in charge of Mr. Swinden to explore the region to the west of Lake Torrens left Port Augusta in August, 1857; but the notes we have of it are short and unsatisfactory, amounting to little more than the bare mention of distances between one creek, pool, or spring, and another, and of the character of the water in each, whether brackish or fresh. The great number of such bodies of water, and their nearness to each other, have excited much interest respecting this region, and the reader will doubtless be pleased to learn that a strongly equipped expedition is probably now on the ground, and that the vigorous prosecution of the instructions which Mr. B. Herschell Babbage, its leader, received from the government in February, 1858, will soon result in an accurate knowledge of this now unknown territory. We may add that there are accompanying this expedition, not only a surveyor, but a chemist and a botanist.

HEIGHT OF THE HIMALAYAN PEAKS.—The survey, now in progress in Caschmir and Thibet, under the direction of Col. A. S. Waugh, has lately determined the height of one of the peaks of Kara-Korum, and ascertained it to be 27,928 English feet, more than 1000 feet above the Dhaulagiri, and therefore the third in height of all the peaks in the world yet measured.

The following measurements are given for the highest Himalayan peaks:

Mount Everest	29,002	English feet.
Kintschindjunga	28,156	"
Kara-Korum	27,928	"
Dhaulagiri	26,826	"
Tschumalari	23,946	"

GUYOT'S PHYSICAL TABLES.—Upon another page of this number a detailed account is given of the Meteorological and Physical Tables, prepared with the greatest care, by Prof. Arnold Guyot, of which a second enlarged edition has reeently been published (Washington, Smithsonian Institution, 1858). We allude to the subject here for the sake of calling the attention of those who are interested in geographical investigation, to a variety of tables which they will find of great convenience and value.

D. C. G.

Yale College Library, Dec. 4, 1858.

ART. XI.—*Biographical Notice of Dean Conybeare and Alcide D'Orbigny;* by Major General PORTLOCK, President of the Geological Society of London.*

1. DEAN CONYBEARE.

IT has been justly said of Dean Conybeare that he was one of a *race* of clergymen, and those, men of intellectual eminence. His grandfather was Dean of Christchurch and Bishop of Bristol, the friend of Bishop Berkely, and the author of a work distinguished even in an age of deep thinkers and profound theologians, entitled, "The Defence of Revealed Religion." The Bishop's only son, Dr. Willian Conybeare, Rector of Bishopsgate, left behind him two sons, both of whom were eminent men. The elder, John Josias, Vicar of Bath Easton, was an accomplished scholar, no inconsiderable chemist, a sound geologist, and filled with credit the University offices of Professor of Poetry and of Anglo-Saxon, as well as that of Bampton Lecturer: he promoted the revival of Saxon literature, and left behind him, on his death in early life, a volume of translations which it was his brother's office to complete and edit. That brother, the second son of Dr. William Conybeare, was the illustrious object of this notice, William Daniel Conybeare: he was born in June 1787, and in due time sent to Westminister School, where he received his early education. From Westminister he proceeded to Oxford, and entered Christ Church in the same year as his fellow collegian Sir Robert Peel, taking a first class in classics, in which he was classed with Sir Robert, and a second class in mathematics, in which he was classed with Archbishop Whately. Until he took his M.A. degree, he continued to reside at the University, pursuing various studies, and assisting by his exertions to lay the foundation of geology, which was then only a rising science. At the early portion of the present century, an indifference, such as we can now scarcely understand, as to the cultivation of the natural sciences prevailed at Oxford; but, in the midst of the consequent general neglect, a small band of individuals, residents of the University, were united in the effort to keep alive a taste for at least one branch of natural science, and succeeded in enlisting others in its cause.

The first lectures given at Oxford on Mineralogy, which was then as a study not accurately distinguished from Geology, were, it is believed, those delivered by Sir Christopher Pegge, then Regius Professor of Medicine; and although it may not be possible, either from written records or from the personal testimony

* From the Anniversary Address of the President of the Geological Society of London, Feb. 19, 1858. Quart. Jour. Geol. Soc., vol. xiv, Part 3.

of any one now living, to form an accurate opinion of the merits of those lectures, it may be fairly assumed that they were not destitute of attractiveness, as the same individual delivered long afterwards lectures on Anatomy, remarkable for an elegance and a fluency of diction which have caused them to continue fresh in the recollection of many. Sir Christopher Pegge was succeeded by Dr. Kidd, who for several years gave courses of lectures at Oxford on both the allied sciences, Mineralogy and Geology, and collected around him a knot of persons interested in similar pursuits, who formed themselves into a little club of Oxford Geologists. This club included amongst its members the late Dr. Buckland, the two brothers Conybeare, the late Rev. Philip Serle, of Trinity College, afterwards Rector of Addington, Oxford, and many others, who, though less vigorously devoting themselves to geological research, were still, from their eminent qualities and high character, most instrumental in keeping alive the growing interest for the new science, and in raising the character of the club so high, that some of the early members of the Geological Society of London, then in its infancy, amongst whom were the late Mr. Greenough and the present patriarch of our science, Dr. Fitton, were in the habit of paying an annual visit in Whitsunweek to the University, in order to explore, under the guidance of the geologists of Oxford, the physical structure of the rocks in its neighborhood; whilst, on their part, they thus judiciously enlisted local inquirers in the service of general geology.

The venerable Principal of Magdalen College, Dr. Macbride, is the only survivor at Oxford, of this memorable club, and he preserves at an advanced age the vigor of his faculties, and exhibits all his former interest in the progress of learning and of science; but of non-residents, there still survive Archdeacon Hony, now Prebendary of Sarum, and Mr. Philip Duncan, who now resides at Bath: the latter and his brother, Mr. John Grant, were Fellows of New College, were honored by the degree of D.C.L., and were remarkable not only for their love of natural history, but for their zealous support of every philanthropic and scientific object. The Rev. William D. Conybeare was, however, in the first rank of this little body, and stood so high in the estimation of all its members, that Dr. Buckland, when first lecturing as the successor to Dr. Kidd, expressed in the warmest terms his sense of the obligations he owed to him for the information he had imparted on points relating to geology, and his persuasion that it would not have been fitting for him to offer himself to fill the office of lecturer on that subject, had Mr. Conybeare been desirous to occupy it. Let me add here, that another equally eminent individual, the founder of the new school of geology at Cambridge, as Dr. Buckland was of that of

Oxford, has assured me, with a similar frankness, so characteristic of Prof. Sedgwick, that he too looked upon Dean Conybeare as his early master in geology.

In 1814 Mr. Conybeare married, and retired from the University, the scene of his early triumphs, to undertake the quiet work of a country curacy, and nine years afterwards removed to the vicarage of Sully in Glamorganshire, on the presentation of the late Evan Thomas, Esq., his brother-in-law; but, whilst holding the curacy of Banbury and Lectureship of Brislington, near Bristol, he was mainly instrumental, in conjunction with Sir Henry DelaBeche, in founding the Bristol Philosophical Institution and Museum, and it was at that time he received a visit from the great French geologists, M. Elie de Beaumont and M. Dufrénoy, who came for the purpose of acquiring a knowledge of the secondary rocks of England, as a standard of reference for those of France; and he so deeply impressed them, whilst acting as their companion and guide in an exploration of the neighborhood, with a sense of his geological knowledge, that they were prepared on their return to coöperate with Cuvier in obtaining the election of Mr. Conybeare as a corresponding member of the Institute for Geology. Nor must it be supposed that this excellent man neglected his sacred duties whilst storing his mind with the richest treasures of geological research, as it was during his residence at Sully that he delivered, gratuitously, at the request of his friend Dr. Prichard, a course of theological lectures at Bristol College, of which institution he had become a visitor.

In 1836 he left Sully and went to Devonshire, having presented himself to his family living of Axminster, and, whilst there, preached, at the request of the authorities of the University of Oxford, the Bampton Lecture for 1839. The living of Axminster he resigned after a few years, on being called by his friend Bishop Copleston to the care of the Cathedral of Llandaff. Here he continued zealously to carry on the good work of restoration which had been commenced by his predecessor Dean Bruce Knight; and, as at all times in his life, he was ever ready to distribute the rich and varied stores of his mind for the benefit of his fellow-men in whatsoever station of life they might have been. This venerable, much-loved man, and admired philosopher, left Llandaff to attend the death-bed of his eldest son, and, whilst pausing in his return at the house of another son, was stricken with pulmonary apoplexy, and died on the morning of the 12th of August, after an illness of only three hours, in the 71st year of his age.

Such is the general picture of the life of a truly estimable man; and I shall now add to it a very brief notice of his most characteristic works, premising, however, that, even before the

peace of 1815 had opened the Continent to British geologists, Mr. Conybeare had formed, from the imperfect data then within his reach, a sound opinion as to the identity of the Jura limestone with the oolitic formations of England, an anticipation which he had afterwards the gratification, in conjunction with Dr. Buckland and Mr. Greenough, of verifying. The versatility of the genius of Dean Conybeare led him to examine and describe the lesser points connected with organic remains, as well as the greater; a circumstance in which he strongly resembled his friend and fellow-laborer, Dr. Buckland. For an exemplification of this peculiarity of his mind, I shall refer to his paper published in the year 1844, in the second volume of the Transactions of the Society, and therefore one of his early contributions to palæontological science. It was entitled, "On the Origin of a remarkable Class of Organic Impressions occurring in nodules of flint." Mr. Parkinson had described them as "small round compressed bodies, not exceeding the eighth of an inch in their longest diameters, and horizontally disposed, connected by processes nearly of the fineness of a hair, which pass from different parts of each of these bodies, and are attached to the surrounding ones; the whole of these bodies being thus held in connexion." Mr. Parkinson considered that these bodies were the works of polyps, and he therefore classed them with corals of some unknown genera; and Dr. Buckland, who had directed his attention to them simultaneously with Mr. Conybeare, considered that the moulds in which the siliceous casts had been formed were the work of parasitic insects, the thin hair-like appendages having been the passages of entry first made by the insects, and the larger flattened bodies the cavities afterwards excavated, the object of the excavation having of course been to obtain nourishment from the body thus eaten into, whether a shell or any other. This observation of Dr. Buckland was communicated to Mr. Conybeare, but not until he had completed his own researches, and arrived at the same virtual conclusion,—namely, that "these cellules were the works of animalcules preying on shells and on the vermes inhabiting them." In arriving at this conclusion, Mr. Conybeare was guided by the examination of various fragments of shells, still preserved in contact with the siliceous matter which had subsequently been infiltrated into the cavities produced by the boring animal. These appear to have been portions of shells distinguished by a striated texture, and were stated by Mr. Conybeare to resemble in structure the recent *Pinna marina*, as the genus *Inoceramus* does; but in addition to these, Mr. Conybeare found them connected with other shells, and even with an *Echinus* and *Belemnite*. Though Mr. Conybeare spoke with diffidence of his having brought before the Society a paper on such minute palæontology, it cannot

ubted that the interest connected with the discovery of the ence and workings of minute marine animals at so remote och is of a very high order. The flints and other siliceous its of the chalk and other geological epochs, have indeed striking examples of the effect of judicious investigation in ring the most obscure objects the means of throwing light natural phenomena.

. Conybeare was fully aware of the necessity of studying cal as well as organic phenomena in connexion with geo- l science; and it is truly surprising how often the intimate xion of the physical geography of remote epochs with natural history is overlooked. His description of the land- which occurred on the coast of Culverhole Point, near outh, in December 1839, was ably illustrated by a series of raphic plates from the drawings of the present Lieut. el Dawson; and the magnitude of the results was well ex- ed by the following words: "Although this convulsion can be ascribed to the less dignified agency of the land-springs antly undermining the sub-strata, yet, in the grandeur of isturbances it has occasioned, it far exceeds the ravages of arthquakes of Calabria, and almost rivals the vast volcanic es of the Val del Bove on the flanks of Etna." Without t these phenomena are very striking and interesting in selves: but they become still more so when we reflect as Robert Mallet has taught us to do, that they ought not to be ned to the existing epoch alone, but should be sought for in tony records of past ages. The paper on the Hydrographi- asin of the Thames, written with a view to determine the s which had operated in forming the Valleys of the Thames ts tributary streams, is equally valuable as tending to main- the value of attending to physical geography in geological tigations. His examination, also, of the Theory of Moun- hains, then recently propounded by M. Elie de Beaumont, ell as his remarks on the phenomena of geology which directly bear on theoretical speculations, are proofs of the philosophical and enlarged view he took of his favorite ce.

noticing the works of Dr. Buckland, I have already de- l the importance of the paper which was compiled by him njunction with Mr. Conybeare, on the Bristol and South h Coal-fields; one, as I then observed, of those elaborate comprehensive papers which were the fitting work of the pioneers of geological science, and the difficulty of which carcely be appreciated in these times when the foundations e science have been fairly laid, and geologists have only to ove or correct the details. His remarks on the sections of Antrim and Derry coast were also a conjoint work, and of h interest.

Another and equally remarkable work was that undertaken in conjunction with the late Mr. William Philips, namely, the "Outlines of the Geology of England and Wales," as it may be considered the first systematic work on the subject; and, though geology has been since more specialized and studied in minuter detail, this work will always be regarded as a striking proof of the ability and knowledge of the authors.

It was, however, in 1821 (April 6) that Mr. Conybeare communicated to the Society that remarkable Palæontological paper which excited so much interest at the time, and established in the most satisfactory manner the propriety of establishing a new genus of *Reptilia*, forming an intermediate link between the *Ichthyosaurus* and Crocodile, to which Mr. Conybeare gave the name of *Plesiosaurus*.

The discovery of immense vertebræ of oviparous quadrupeds in the Lias near Bristol had attracted the attention of Mr. Conybeare, who quickly recognized the difference between those belonging to the *Ichthyosaurus* and others, which evidently in his opinion were portions of a different animal. With a singular acumen and rare sagacity, he placed the detached vertebræ in their proper position, and finally established his new genus, for which he adopted the name *Plesiosaurus*, as expressing its near approach to the order Lacerta.

For the whole group of animals which approximate, on the one hand, to the crocodiles in general organization, and yet have been provided with such specific organs as were necessary to enable them to live, at least principally, in the sea, Mr. Conybeare proposed the name *Enaliosauri*, as a classic appellation for the whole order; and he observes of the genera composing it, that even the *Ichthyosaurus*, which recedes most widely from the forms of the Lizard family, and approaches nearest to those of fishes, exhibits in its osteology a beautiful series of analogies with that of the crocodile, and which widely remove it from fishes.

In this paper he then described in the minutest detail the osteology of the *Ichthyosaurus*, and exhibited a knowledge of anatomy which excited the admiration of every one. He then examined with equal care the relics of the new genus, which, although at that time not complete, were sufficient to enable Mr. Conybeare to conclude that the vertebral column recedes from that of the *Ichthyosaurus* in all the points in which the latter approaches to the fishy structure, and that the invertebral substance must have been disposed much as in *Cetacea;* and that, from the locking together of the articulating processes, it must have had much less flexibility than in the *Ichthyosaurus* or in fishes. In examining also such portions of the paddles as could be arranged in order, he comes to a similar conclusion in another direction, namely, that the paddles of the *Plesiosaurus* are inter-

mediate in character between those of the *Ichthyosaurus* and the Sea-turtles; and thus in every respect he laid a sound foundation for his new genus.

It is to be remarked that this paper was given as the joint production of Mr. Conybeare and Sir Henry De la Beche, to whom Mr. Conybeare most liberally ascribed a full share of the merit of the discovery; but, allowing Sir Henry every praise for his assistance in that discovery and in all the geological details, I believe the sagacity and skill exhibited in the osteological details and reasonings have always been ascribed to Mr. Conybeare.

In a second paper, read May 3, 1822, Mr. Conybeare was enabled to describe much more fully all the relations of the genera *Ichthyosaurus* and *Plesiosaurus*, from the discovery of other remains, both of the *Ichthyosaurus* and *Plesiosaurus*, by his coadjutor Sir Henry De la Beche. A very minute examination of the teeth, especially, enabled him to point out that those of the *Icthyosaurus* were more intimately related to the teeth of the crocodile than to those of other *Lacertæ* (an opinion then at variance with the opinions of some anatomists), whilst at the same time, in other respects, the analogy was in the other direction, for Conybeare observes, "in pursuing, however, the history of the teeth of the *Ichthyosaurus* to the last stage, we quit these analogies with the crocodile, and arrive at another point wherein the *Ichthyosaurus* resembles the other *Lacertæ*, in common with many of the *Mammalia:* this is the gradual obliteration of the interior cavity in old age, by the ossification of the pulpy nucleus." In conjunction with Sir H. De la Beche he brought up the number of species to four, determined from the teeth; and in his further consideration of the genus it is right to notice the following remarks, proceeding from him after noticing a difference in one character of the fossil crocodile, when compared with the recent, as stated by Cuvier:—"I am persuaded from every circumstance, that a much nearer approximation to the structure of the older lacertian genera will be found in the fossil than in the recent crocodiles: interesting links in the chain of Saurian animals will be thus supplied, and it will probably be found that many of the points in which the *Ichthyosaurus* differs from the recent type are only instances of its agreement with the fossil."

The researches of Sir H. De la Beche had not at this time led to the discovery of a complete skeleton of the new genus *Plesiosaurus;* but additional portions of it were found, including a very perfect dental bone of the lower jaw, whilst a tolerably perfect head was discovered by Mr. Thomas Clarke in the Lias of Street, near Glastonbury.

The investigation of these new relics of the *Plesiosaurus* led Mr. Conybeare to the following conclusion: "On the whole then, the manner in which the ribs of the *Plesiosaurus* articulate

throughout, by a single head, to the extremity of the transverse processes of the vertebræ only, the structure of the humerosternal parts, and the characters derived from the head, approximate this animal most nearly to the *Lacertæ*. By its teeth, on the other hand, it is allied to the crocodile; while its small nostrils and multarticulate paddles are features in which it resembles the *Ichthyosaurus*." This able paper he concluded with words characteristic of his natural modesty, after pointing out the difficulty of rendering anatomical details at once scientifically accurate and yet attractive to a general audience: "I need not add how much these difficulties will be increased in the hands of a writer who must acknowledge that, while intruding on the province of the comparative anatomist, he stands on foreign ground, and, using almost a foreign language, is frequently driven to adopt an awkward periphrasis, where a single word from the pen of a master would probably have been sufficient."

However some may at the time have been inclined to throw doubts upon the deductions of Conybeare, the ability and accurate discrimination of the author were publicly recognized by the great Cuvier, who hastened to advocate his admission to the French Academy as a Corresponding Member for the science of Geology; and I am sure that all living palæontologists will follow the example of the late well-known, and at that time so highly respected, Mr. Clift, in recognizing the great merits of Dean Conybeare, and considering him one of the principal founders of the science in this country.

At the present moment it would be tedious and unnecessary to pass in review the whole of the long series of Mr. Conybeare's geological works, nineteen in number; and I shall point your attention therefore solely to that able "Report on the Progress, Actual State, and Ulterior Prospects of Geological Science," which he presented to the British Association in 1832, at its meeting in Oxford, in which he treats the subject with the combined powers of the scholar and man of science, pointing out the remarkable analogy in the views of Leibnitz to those of many modern speculators on physical geology; the opinions of Hooke in respect to the hypothesis of the elevation of our continents by volcanic agency; the masterly observations of Smith, first made known in 1799, which, although not the first to originate the doctrine of a regular distribution of organic remains, yet reduced to certainty and order what had been before vague and conjectural; the gradual rise of the Tertiary Geology from its foundation in the admirable "Memoir on the Basin of Paris," by Cuvier and Brongniart, published in 1811; the establishment of the Geological Society in 1808, and the labors of all the great men connected with it, including, amongst many others, Greenough, Buckland, Sedgwick, Fitton, Murchison, De la Beche, Phil-

rope, Daubeny, and Lyell, together with those of foreign sts, including the great Von Buch and Boué. That Re-me is sufficient to prove his masterly acquaintance with tory of his favorite science, and with all its bearings, t marks the liberal spirit with which he entered into all cal inquiries. The advance of geology since that Report n enormous; and, if a period of twenty years from the tion of Cuvier and Brongniart had done so much in Tertiary Geology to a high position, may we not say that ilt of the next twenty-five years has been still more re-le, and has richly rewarded the continued and judicious ies of some of our most distinguished geologists, such as Forbes, Prestwich, and Austen, whilst the elevation to the Silurian system has arrived by the persevering exer-f Murchison is a monument of progress which we can r hope will be equalled in that peculiar branch of geology e times.

zeal of Dean Conybeare for geology never forsook him; en obliged to visit Madeira on account of the health of ngest son, he visited the Peak of Teneriffe, and studied er volcanic phenomena of the neighboring islands. How must we regret that his last days were embittered by for the death of another son, from whose funeral he was ig at the time of his death! But so excellent a man, d for death by the strict performance of every Christian iring life, requires not the commiseration of those who him; although all who recollect his air of gravity and rity, which always made his words effective in command-ention and respect, and in bringing home conviction to ids of his hearers, must feel how heavy a loss we have nced.

2. Alcide D'Orbigny.

le D'Orbigny, Professor of Palæontology at the Museum iral History in the Jardin des Plantes, was remarkable vast magnitude, as well as for the interesting character palæontological works, intended as they were to embrace ole field of geology in France, and, of course, compara-o notice the relations of the ancient inhabitants of all s of the earth whilst describing those of his native coun-Mr. D'Orbigny was born at Couëzon (Loire Inférieure), s, in succession, Travelling Naturalist for the Museum of l History, Secretary of the Natural History Society, r of the Central Commission of the Geographical Society, nt of M. Cordier in the Geological Course, and latterly it of the chair of Palæontology which had been created ly for him. He was a Knight of the Legion of Honor.

Mr. D'Orbigny commenced in 1826 his travels for the Museum, under the auspices of the government. As a student at Rochelle, D'Orbigny passed his earlier years on the sea-shore, and employed much of his time in examining the natural productions thrown ashore by the waves. Before he had attained the age of twenty-two, he presented to the Academy a work which was attended with great success, as the committee appointed to examine it reported that, from the great number of new species he had made known, he deserved to be placed in the first rank of original observers. In 1826 he proceeded, as Travelling Naturalist for the Museum, on a voyage to South America, where he explored, with equal perseverance, courage, knowledge, and success, Brazil, Buenos Ayres, the frontiers of Patagonia, and the Republics of Chili and Bolivia, from the shore of the Pacific Ocean to the centre of the continent: he afterwards went through the Republic of Peru, and, when he returned to France, had visited all that portion of the earth from the 11th to the 12th degree of latitude, and from the Pacific to the Atlantic Ocean.

As the product of this voyage, Mr. D'Orbigny brought home most extensive collections and manuscripts, numerous drawings of objects of natural history, and everything necessary to illustrate the geography, the languages, the ethnology, and archæology of this part of America: historical manuscripts, thirty-six vocabularies of the American language, a collection of animals containing 7000 species, of which many were new, and one of about 2300 species of plants, as well as much information respecting the geology of the countries he visited, were amongst the results of his labors, and were embodied in the great work entitled, "Voyage dans l'Amérique du Sud," published under the sanction of the Minister of Public Instruction. He also superintended the publication of another work, "Voyage pittoresque dans les deux Amériques;" and his labors were appreciated by the Geographical Society of France, which awarded him its annual prize in 1836. As an active, intrepid, and persevering traveller, he had thus made his way over an immense extent of country, from Brazil and Peru to Patagonia, in eight successive years, sometimes navigating previously unknown rivers, sometimes penetrating virgin forests, resting on the loftiest plateaux of the Andes, or in the plains of Patagonia, frequently finding himself amongst contending tribes, and being obliged to take part in their conflicts.

Alcide D'Orbigny, who had thus studied nature under all its varied forms, now devoted himself to a task not less deserving of the admiration of posterity, as he thenceforth consecrated his life to the study of Palæontology, a science which had only sprung into existence in the nineteenth century, and which has

nabled the geologist to study the ancient natural history
veral epochs of the earth's history, and to determine by
the true *relative* age of the mineral deposits with which
relics of animals and plants, long since removed from
on as existing genera and species, are associated. It
justly said that what he succeeded in accomplishing in
branch of science, was so vast as to be almost beyond
igence, and, I may add, the physical powers of any one
d, as a proof, I will at present mention his Foraminifera
of the Canaries, of Meudon near Paris, and of Vienna;
es on the Crinoids, his "Prodrome de Paléontologie,"
rse of Stratigraphic Geology," and especially his "Palæ-
of France," which has extended to fourteen volumes,
ins 1400 plates of French fossils.

D'Orbigny was removed by death only four years after
en chosen Professor at the Jardin des Plantes, and before
ad time to complete his great palæontological works,
is believed that he has laid the foundation of a palæ-
al collection worthy of France. I have on a former
spoken of the nomenclature introduced by him into
which, although founded in great measure upon that
y adopted in England, deserves, from its simplicity,
any respects its euphony, the ready reception which it
ned on the continent. In respect to his great work on
ontology of France, I am aware that many English
logists consider that he has been sometimes too hasty
ation of new species; but this error, I fear, is common
e portion of palæontologists, and will not be entirely
until naturalists have made their comparisons, not with
but with actual specimens. Making, however, every
on that account, the works of Mr. D'Orbigny must ever
h as a memorial of the most persevering industry and
order of intellect, in confirmation of which opinion I
ly but more particularly notice some of his numerous

ig so I shall principally confine myself to the notice of
s and opinions of D'Orbigny as affect materially either
sophy or the practice of geological science. Such
his Monograph of the new genus of Gasteropods to
gave the name *Scissurella*, or his description of two
the genus *Pterocera*, found in the Jurassic limestone
arente Inférieure, or his essay on the beaks of fossil
oda, in which he divides the Rhyncholites into two di-
elonging to different genera, one being the beaks of
nd not of *Sepiæ*, as had been before supposed,—an idea
by the anatomical description, by Professor Owen, of

the *Nautilus Pompilius*,—or his note on the genus *Caprina*, his tabular view of the class Cephalopoda, his memoir upon a second living species of the family of Crinoids, to which he gave the generic name *Holopus*, and many other of his papers, are sufficient proofs of his great knowledge of, and accurate judgment upon, almost all branches of natural history; but others speak the language of a philosopher on such subjects.

Every one will doubtless remember the different opinions which were once entertained on the true position, amongst organized beings, of the Foraminifera, some naturalists having, from the resemblance of form, allotted them to the Cephalopoda. After a careful examination of the animal portion as well as of the shelly covering of these minute, often microscopical, bodies, he disproved the earlier notion of their alliance to the Cephalopods, which he had himself at first adopted, and proposed a general classification of the Foraminifera, founded upon the form of their shells, placing them amongst the Radiata, close to the Polyps. In this great and important inquiry he described and figured 118 new species from the Island of Cuba and from the Antilles, and afterwards 43 species from the Canaries, of which 33 were peculiar to those islands. Nor was it to living Foraminifera that he confined his attention, as he described and figured 54 species from the white chalk of the Paris basin, all, with the exception of three or four, new, and then again those which had been discovered by M. von Hauer in Austria, ending by the following statement of the geological distribution of Foraminifera:

	Genera.	Species.
Palæozoic strata	1	1
Jurassic strata	5	20
Cretaceous strata	34	280
Tertiary strata	56	450
Existing epoch	68	1000

So that it would appear that the genera and species were few in number and simple in structure at first, and increased both in number and complexity of structure from formation to formation, until they had obtained their maximum of development in the present seas. D'Orbigny even considered that this gradual advancement from simple to compound was more distinctly manifested in these minute beings than in any others, and that they are in consequence the best fitted for determining with precision the relative ages of geological strata. The following ten living genera, *Gromia*, *Rimulina*, *Conulina*, *Vertebralina*, *Caudenia*, *Pavonina*, *Robertina*, *Cassidulina*, *Uniloculina*, and *Cruciloculina*, M. D'Orbigny named as not having been as yet discovered in a fossil state; and he gave the following view of the climatal distribution of the Foraminifera, which also cannot fail to be

very suggestive to the palæontologist. Torrid Zone, 375 species; Temperate Zone, 350; Frigid Zone, 75: so that, as in Mollusca, the seas of hot climates are more productive of species of Foraminifera than those of colder regions.

D'Orbigny traces the history of these bodies from their first discovery in 1731 to the present time; and as a proof of the importance of the office they may have played in the formation of some geological strata (the houses of Paris and the pyramids of Egypt being in part built of rocks composed of Foraminiferous shells), he states that little more than an ounce in weight of the sand of the Antilles yielded 480,000 of these shells. D'Orbigny concluded, from his examination of the Foraminifera of the Paris basin, that they had lived in a hot climate, and had not been subjected to the wearing action of any current.

In explaining the distribution of the Foraminifera of South America, Mr. D'Orbigny points out how varied the groups are, under the influence even of chorographic differences,—the Foraminifera of the southern shores of the Pacific differing from those of the southern shores of the Atlantic, and both from those of the equatorial region of the Antilles, from which fact he deduces the conclusions, that in the same sea, and in connexion with the same continent, different fauna may exist at very small distances from each other; and further, that Tertiary basins, although different in their fauna, may have been formed simultaneously, just as the material deposits are necessarily widely different in character at localities by no means very remote. Unquestionably the reasoning is good, and equally applicable to the geological deposits of all ages of the world.*

In his essay on the distribution of the Acetabuliferous Cephalopoda, he states, in reference to their present distribution, that 15 out of 16 genera are found in hot countries, 10 in temperate regions, and 6 only in cold; and he also concludes, from his inquiries, that these forms are more complicated as they inhabit hotter regions, and further, that it is probable the fossil genera

* It must not be assumed from my remarks on D'Orbigny's labors in the *Foraminifera*, that I consider him to have arrived at his final results *per saltum*. Far from it, as in 1826 his object, as so well explained by Férussac, was simply to separate the microscopical *Cephalopoda*, as he then considered them to be, from the Siphoniferous genera with which they had been confounded. De Haan had previously proposed such a separation, and founded upon it his *Siphonoides* and *Asiphonoides*; but D'Orbigny felt that there were other differences, and therefore proposed his more distinctive term *Foraminifera*. His "Prodromus," published at that time, was founded upon this view of the subject, and remained the standard of classification until Desjardins, in 1835, gave many reasons, deduced from careful observation, for separating the *Foraminifera* from the Mollusca entirely, and forming of them a totally distinct class, to which he gave the name *Symplectomères*. Desjardins therefore gave the impulse which has since led to the correct classification of these microscopical but most interesting animals, which have been shown, by the examination of the deep-sea soundings of the Atlantic, to be as active now as in ancient epochs in laying the foundations of future strata.

lived under a high temperature. Taking account of this view of the subject, it is interesting to observe the other statement of M. D'Orbigny, that the Acetabuliferous Cephalopoda appeared first in the Jurassic formation, when they were represented by the *Belemnites* and six other genera, including the existing genus *Sepia* and three other living genera, simultaneously with the vast numbers of *Ammonites;* that all disappeared except the genus *Belemnites* in the Cretaceous epoch, being represented, however, by different species; and that in the Tertiary strata, the *Belemnites* disappeared entirely, being replaced by the genus *Sepia* appearing for the second time, and the genus *Beloptera*, which appeared, only to pass rapidly away, as it is no longer a living genus. These are unquestionably very remarkable facts; and have on the one hand a tendency to support the doctrine which M. D'Orbigny so strongly supports, of the destruction of one creation and the production of another again and again at successive epochs, whilst, on the other, they may induce a pause in the decision of the palæontologist, as it seems difficult to conceive that any such genera as *Sepia*, *Sepioteuthis*, &c., could have been created so far back as the Jurassic age, and then have totally disappeared, to be *again created* in the Tertiary and existing epochs. I must again maintain that it is more natural to conceive that the link of connexion between the dead and the living has been kept up, although hitherto the region of their habitation, during the long period of time elapsed, has been veiled from observation.

I shall not attempt further to follow the able author of no less than fifty distinct treatises, some of vast magnitude and interest, and all full of ingenuity and knowledge; but I may notice him as the author of that nomenclature which is gaining ground rapidly; and in doing so I will quote, as illustrative of his method, the distribution of the Bryozoa-Cellulina, which he thus details:—

		Genera.	Species.	
Terrains Crétacés.	Etage Néocomien	1	1	593 species.
	— Aptien	1	1	
	— Albien	1	1	
	— Cénomanien	11	26	
	— Turonien	9	17	
	— Sénonien	54	547	
Terrains Tertiares.	Etage Suessonien	3	5	109
	— Parisien	12	24	
	— Falunien	40	75	
	— Subapenin	4	5	
Existing Fauna.		58	312	312

he Bryozoa-Centrifugina, which form the other division of class, he discovered in almost all the geological formations, he gives their numbers thus:—

	Genera.	Species.
In the Palæozoic	10	66
—— Triassic	0	0
—— Jurassic	32	93
—— Cretaceous	130	480
—— Tertiary	32	101
—— Existing epoch	26	80

l he concludes from the whole that there were *three centres* of ·lopment of the Bryozoa, the first two composed of B. Cen- gina alone,—namely, one in the Carboniferous stage of the ›ozoic, and one in the Bathonian of the Jurassic,—and the r composed of both orders, Cellulina and Centrifugina, in Senonian stage of the Cretaceous.

aving now, I trust, enabled every one to form a correct ment of the great and varied abilities of Mr. D'Orbigny, in of whose researches the Society has twice awarded the pro- s of the Wollaston Fund, I will close my remarks with the wing passage from the report of Messrs. Brongniart, Dufré- and Élie de Beaumont, on his "Geology of South America," conveys a sentiment in which all our members will, I am cordially concur:—

The author's reserve, in treating upon a subject so vast and cult, cannot but be approved, although no one can fail to eive that the memoir of M. D'Orbigny has enriched science a great number of new facts and with many ingenious ulations. New observations may hereafter lead to a modifi- n of some of his theoretical views; but the merit will ys be his of having considered a vast subject from a point bservation so elevated as must necessarily cause it to com- d attention, and lead the way to still further progress. We efore propose to the Academy that it should express to the ıor the high satisfaction it has experienced in contemplating indisputable advancement which has been made towards a wledge of the geology of South America, by his courageous persevering researches:"—let me also add, towards a knowl- e of the geology of all parts of the earth; for his great works he Palæontology of France deserve such commendation.

Art. XII.—*Caricography;* by Prof. C. Dewey.

(Continued from vol. xxiv, p. 48, Second Series.)

No. 254. *Carex Geyeri,* Boott, Lin. Trans., vol. xx, p. 118, Kunze, No. 55. Illus. Car. Boott, No. 98, Tab. 105.

Spica unica androgyna, superne staminifera cum squamis oblongis obtusis, inferne pistillifera; fructibus 1–4 alternis subremotis tristigmaticis obovatis triquetris ore integris et albis inferne productis vel stipitatis glabris, squamam oblongam magnam amplectentem cristatam subæquantibus; culmis superne foliaceo-bracteatis.

Culm a foot high, slender, sometimes scabrous above, with stiff radical leaves as long as the culm and rough on the edges; spike single, an inch or more long, upper half inch staminate and slender-cylindric with long and oblong close whitish scales; the lower part pistillate, with 1–4 large fruit, which are separate and subremote or scattered, sometimes 4 fruit along an inch, often fewer and nearer, the upper fruit sometimes one-fourth inch below the staminate; stigmas 3; pistillate scale broad, oblong, clasping, more or less awned, and a little longer or shorter than the fruit.

Mountains of North America; C. A. Geyer, in honor of whom it was named; also, Duffield's Ranch, Sierra Nevada; Dr. Bigelow, Explorations for Pacific Railroad, vol. iv, p. 163.

This species is related to *C. phyllostachys,* Meyer, which has a shorter and ovate fruit with a scale very long and leaf-like. Its association is with *C. Wildenovii,* Schk.

No. 255. *C. decidua,* Boott, Lin. Trans., vol. xx. p. 119. Illus. Car. No. 157, p. 63, Tab. 170.

Spicis 3–6 cylindraceis erectis gracilibus atro-purpureis; suprema staminifera brevi-pedunculata clavæ-formi interdum basi vel medio pistillifera, squamis oblongis obtusis vel obovatis dorso albi-nervosis instructa; pistilliferis 1–5 distigmaticis sessilibus bracteatis, superioribus 1–3 brevibus parvis contiguis interdum geminatis apice staminiferis, inferioribus 2 longioribus subremotis foliaceo-bracteatis; fructibus oblongo-ovatis vel obovatis rostellatis inferne teretibus deciduis nervosis ore integris, squama oblonga obtusa dorso pallida subduplo brevioribus.

Culm a foot or more high, triquetrous and quite rough on the edges above and leafy towards the base, and sheathed, rather slender; staminate spike single, short-pedunculate, often pistillate at the base and sometimes in the middle, longish and club-form, with staminate scales oblong, obovate, obtuse and white on the keel; pistillate spikes 1–5, erect, sessile, rough-bracteate,

sometimes 1–3 short approximate to the staminate, and staminate also at their apex, and two longer and remoter below, sometimes only 2 or 3 pistillate spikes of which the upper is near the staminate and the other more remote; stigmas 2; fruit oblong, ovate, or obovate, short rostrate, entire at the orifice, nerved and tapering below, but scarcely stipitate; pistillate scale oblong obtuse pale on the back, and near twice the length of the fruit.

First found in Terra del Fuego; afterwards with the preceding, by Dr. Bigelow, as noticed in the same work. My specimens are from the latter locality.

NOTE.—As the authority of Willdenow led to the confounding of *C. paleacea*, Wahl., with *C. crinita*, Lam., it is important to say *how* the confusion has been ascertained and the mistake corrected. This has been done by Dr. Boott in his "Illustrations of the Genus Carex," a title so unpretending of a magnificent work on Caricography, finely characterized by Prof. Gray in the July number of this Journal.

Wahlenberg gave a specimen of his *C. paleacea* to Mr. Tuckerman, who passed it to Dr. Boott. It proved to be the *C. maritima*, Vahl., and of course, was very far from *C. crinita*, Lam. But our botanists had long before found a plant, which was figured by Schk. as one form of *C. crinita*, and they were thence led to call another apparent form of it, var. *paleacea*, as being the *C. paleacea*, Wahl.; Schk. supported the same mistake. Having thus corrected the mistake of Willd. and error of Wahl. and of Schk., Dr. Boott saw that our *so-called* var. *paleacea* is the real *C. crinita*, Lam. Hence, the other form of it must be the variety, if it belongs to it. But Dr. Boott shows the manifest difference between them, and gives to this the name *C. gynandra*, appropriated to it by Schweinitz as early as 1824. The true *C. crinita*, Lam. then is ascertained, and another species is named. This and its synonyms will be as follows:—

No. 256. *C. gynandra*, Schw., An. Tab. Boott Illus. Car., No. 48, Tab. 50. *C. crinita*, Schk., fig. 125, Tab. Eee, not of Lam. Dew., Sill. Journ., vol. x, p. 270, and Am. Auth. Var. *gynandra*, Schw., and Tor., and others.

With the change of names in Sill. Journ., vol. x, p. 270–1, as indicated above, the description there is definite and adequate, as shown by the specimens sent by me to Dr. Boott.

I have not often seen the peduncles of the lower spikes so long as on Dr. Boott's figure. The spikes too are generally larger, often somewhat ventricose in the middle, with more staminate flowers at their tapering summit, and more densely fruited than those presented, or more like fig. 125, Schk. The geographical range is greater than shown by Dr. Boott's speci-

mens, and extends over much of New England, New York, and far into Pennsylvania.

The separation, long desired by some, of this species from *C. crinita*, has thus been accomplished.

It is thus made easy to settle the synonyms of *C. crinita*, common in American authors.

C. crinita, Lam. Boot, Illus. Car., No. 47, Tab. 49. Schk., fig. 164, Tab. Ttt. Muh. Gram., p. 229. *C. leonura*, Wahl. Sartwell Exsic. Car., No. 58. Var. *paleacea*, Dew., Sill. Journ., x, p. 270–1. Tor. Mon., 401. Carey and Gray's Manual, p. 549.

Changing the names in Sill. Journ., vol. x, p. 270–1, as already indicated, the description there will distinguish the true *C. crinita*. Dr. Boott's figure fully and finely shows this species, and is far superior to fig. 164, Schk., above mentioned, though I had in 1826 referred this species to it. The long and slender, whipform, densely flowered spikes, with the long and rough-awned pistillate scales, and the roundish or obovate or oval fruit, short-beaked and ventricose, form distinctive characters. They describe *C. crinita*, Lam., there called var. *paleacea*.

Var. *minor*, Boott, as above.

Spikes smaller and shorter, 1–2 inches long, often nodding, or erect, rather loose-flowered, commonly with a long lanceolate and rough-awned scale.

These characters are plain on my specimens of this variety.

This species differs from *C. gynandru*, Schw., in having smooth, and not scabrous sheaths of the leaves, more slender and longer pistillate, spikes more closely fruited, as well as in the fruit and scale.

Dr. Boott's enthusiasm, position and extensive collection of Carices, as well as his acute discrimination, enable him to make other corrections, some of which at least will much interest our students of this vast and difficult genus. I advert to one more, viz., the proper designation of the species so long known over the country as *C. anceps*, Muh. The proper extension of the species is another consideration on which there may be difference of opinion. It was so named by Muhlenberg, in letters to Willdenow, on account of its *two-edged* peduncles of the spikes, and was published by Willd. under that name, though Muh. afterwards published it as *C. plantaginea*, and yet referred it to Schk.'s figure of *C. anceps*. In 1826 I referred it to the synonym, *C. striatula*, Mx., without any consideration of the priority of the name. Several varieties of it were described, and much later Mr. Carey, in Gray's Bot., named one of them (under *C. anceps*) var. *striatula*, very appropriately. In 1857, Dr. Gray, in his Manual of Botany, referred it to *C. laxiflora*, Lam., and, in 1858, Dr. Boott published the reasons for this reference in his Illustra-

tions, with the synonyms and several varieties. There is much propriety in presenting some of the changes, observing at the same time that this species had been called in our country, to 1857, *C. anceps*, Muh.

C. laxiflora, Lam., 1789, not of Schk.
Boott, Illus. Car., No. 87, Tab. 89, 1858.
Gray, Man. Bot., p. 524, 1857.
C. heterosperma, Wahl., No. 67, 1803.
C. striatula, Mx., vol. ii, p. 173, 1803.
C. anceps, Muh., Letter to Willd.
Willd., vol. iv, p. 278, 1805.
Schk., Tab. Fff., fig. 128, 1812.
C. plantaginea, in part, Schk., Tab. Kkkk, fig. 195, 1812, not Lam.
Muh. Gram., p. 242, 1817, not Lam.
C. anceps, Muh. Dewey, Sill. Journ., vol. x, p. 36, 1826.
Tor. Mon. Cyp., p. 414, 1836, and Am. Auth., var. *patulifolia*, Dew. Carey Ed. 1, and Man. Bot., 1857, and var. *plantaginea*, Boott, both Schk., fig. 195.

This case shows us the principal cause of the numerous synonyms in Caricography, viz., their being named by different botanists in different places and unknown to each other. In so large a genus, embracing more than eight hundred species, in all quarters of the globe, this multiplication of names may easily occur. This species was named by authors in different parts of the world, who knew not those already given. Hence, all the names were correct and legitimate, except the reference of this species in Muh. Gram. to *C. plantaginea*. Interesting as is the correction by Dr. Boott, the point attained shows only the author of the original or first name.

Again; where the so-called variety requires as long, or nearly as full a description, as the species itself, there is no objection to giving it the rank of a species, till it is proved that both forms are produced from the same seed or the one changes into the other in growing. In the well known varieties, as some have called them, this proof has not been attained in one case of a hundred. Some have been called varieties and so described for years, when they have been raised to the place of species, and continue to hold their rank. Besides the instance of *C. gynandra*, already noticed, there are others equally obvious and certain.

For these reasons, it is difficult for me to adopt two of the varieties of this species in Dr. Boott's splendid "Illustrations," viz., *C. styloflexa*, Buck., and *C. blanda*, Dew. Indeed, it needs but little extension of the specific description to comprehend two or three other and admitted species.

ART. XIII.—*On the Variable Illuminating Power of Coal Gas;* by WILLIAM E. A. AIKIN, Prof. Chem., &c., University of Maryland.*

(Read before the American Association for the Advancement of Science, at the Baltimore Meeting, May, 1858.)

IN common with a large number of our citizens, my attention was directed some short time since, to a somewhat sudden, inexplicable and enormous increase in the amount of our quarterly bills for gas consumed; an increase equal at times to an advance of a hundred per cent over the corresponding quarter of the preceding year. As it would have been absurd to suppose a simultaneous derangement of all the meters over an extensive district, it was obvious that the difficulty could not lie in any error in the registry of the gas, but in its illuminating power, necessarily requiring the consumption of a greater bulk of gas to produce a given quantity of light. Feeling curious to know how this difference could have occurred, I set myself to work to ascertain, if possible, what causes could be acting to diminish the illuminating power of the gas.

It has long been known that the quality of the gas produced from the fat coals is very materially influenced by the circumstances of the decomposition. In the elaborate experiments made some years ago on a most extended scale by Hedley, the British Engineer, as detailed in his report to a committee of the House of Commons, we find this subject most satisfactorily discussed. Below a cherry red heat the products obtained by heating coal in close vessels contains hardly any illuminating material. At that temperature it is furnished most freely, but after having been formed is liable to decomposition, involving a loss of carbon by contact with any highly heated surface in passing through the apparatus. Such decarbonization increasing with the degree of heat, with the extension of the red hot surface, and with the time of contact. Again, the duration of heat is most important, the best gas coming over during the first hour, the quality rapidly deteriorating, until at the expiration of four hours the product is worth very little to the consumer, and after five hours may be considered as worthless. But the bulk of such worthless gas that can still be obtained by pushing the process to completion is very considerable, equal sometimes to $\frac{1}{3}$ of all that passes over.

How far any neglect in the observance of the precautions required to produce a proper illuminating gas, may explain the result the public have no means of knowing. All that we know

* The title of the above paper was accidentally omitted when the list of papers read before the Association was published in the July No. of this Journal.

is that the manufacturers furnish an article which they say is the right article and prepared in the right way, and possessing an illuminating power varying from 14 to 17 candles. That is, their engineer reports, that on trial with a photometer, at stated times, the gas burning from a jet, consuming five cubic feet per hour, gives an amount of light equal in the average to that of 15 patent candles six to the pound. The patent candle being ostensibly a mixture of spermaceti and wax. Assuming as true all that is claimed by the manufacturers, it can still be shown that the gas even if properly made and correctly tested may be and is furnished to the consumer in a condition of greatly diminished illuminating power, compelling the consumption of a greater bulk to obtain the required light and consequently swelling the record of the meter and the sum total of the quarterly bills. In my trials to determine the specific gravity of our gas by weighing a globe previously exhausted and then filled with it, I obtained a result ranging from ·570 to ·580 somewhat below that given as characterizing good gas. But in reality I attach very little importance to this result since the mere specific gravity of such a complex mixture as coal gas can hardly be relied upon to determine its commercial value.

Although good gas certainly has a higher specific gravity than poor, yet the difference could not be taken to represent the true difference in value since the principal components of the mixture hydrogen, carbonic oxyd, light carburetted hydrogen, olefiant gas and other still heavier hydrocarbons having specific gravities, widely different, might vary somewhat in their relative proportions sufficient to affect the illuminating power, without at the same time and to the same extent affecting the specific gravity. The action of chlorine in removing the olefiant gas and other more dense hydrocarbons, the principal light giving materials of the coal gas, showed a per centage of these substances never exceeding 10 per cent. But not having time at the moment to guard against all sources of error in the process, laid it aside. My attention was principally directed to the simple inquiry to what extent will the illuminating power of the gas be impaired by keeping it in contact with water for noted periods. That it does deteriorate when thus kept, or when kept in contact with oil or even close vessels has been long known.

Dr. Ure tells us that gas from oil when first made and with a specific gravity of 1·054 will give the light of one candle when burned from jets consuming 200 cubic inches per hour. But keep the gas three weeks and then to get the same light from the same burner you must supply 600 cubic inches per hour. He adds that with coal gas the deterioration appears to be more rapid. For if such gas when first made will give the light of one candle by the consumption of 400 cubic inches per hour,

when kept four days will require the consumption of 460 cubic inches per hour to give the same light. My first attempt to obtain some definite results began on the evening of the 8th ultimo, when I filled a large receiver from the street main and placed it on the shelf of the pneumatic trough, the next evening I filled a second one and put it alongside of the first, the following evening I filled a third receiver, and still the following evening, the 11th inst., I filled a fourth receiver. On the evening of the 12th I was thus provided with four jars of gas, one of which had been standing 24 hours or one day over the pneumatic trough, this I will call No. 1; another, No. 2, had been standing two days; No. 3 had been standing three days, and No. 4 had been four days in contact with the water. The diminution in volume by such exposure was indicated by a receiver graduated to cubic inches into which I introduced 130 cubic inches of gas on the evening of the 8th; on the evening of the 12th this had lost about 10½ cubic inches, indicating a loss of about 8 per cent. of the original bulk.

The effect produced on the illuminating power of the gas by the loss of volume became at once apparent as I proceeded to contrast the value of the flames furnished by the contents of the several receivers, 1, 2, 3, and 4. I used for this purpose the ordinary photometer arrangement, taking the relative intensity of the shadows produced, as a measure of the relative intensity of the light. The candle employed for the comparison was the patent candle already referred to, and the burner was the kind known as fish tail burner, which had been previously guaged, and known to consume a trifle more than 5 cubic feet per hour with the average maximum pressure of the gas works. I need hardly add that the burner was the same in all the trials, and occupied exactly the same position. The burner and the screen on which the shadows fell were not moved at all during the experiments. The only adjustment wanted was to bring the candle nearer to or father from the screen, and by beginning with the most luminous gas the adjustment became simply a gradual withdrawal of the candle.

The capped receiver from which the gas was passed floated freely in a large glass jar, supported in an erect position by the perpendicular sides of the jar, its own weight, with all attachments, making a difference of level between the water around it and that within equal to 3½ inches, a little exceeding the ordinary evening pressure in the gas pipes. This difference of level, and consequently the pressure on the escaping gas, was kept uniform by the spontaneous sinking of the receiver as the gas was consumed, a flexible tube communicating between the stop of the receiver and the gas burner. This arrangement gave me a steady, equable flame, which continued perfectly uniform long

enough to enable me, after a few trials, to note, very exactly, its true value. The results as first obtained were too startling to be at once believed, but subsequent repeated trials satisfied me that they were very close approximations to the truth. The first trial was with the gas from the street main, which I found equal to 10·71 candles. The same gas, transferred from the pipe to the capped receiver, and burned immediately, gave exactly the same power, 10·71 candles. Gas No. 1 was next used, and found equal to only 3·50 candles; Gas No. 2, after standing two days, gave the light of 3·20 candles; Gas No. 3, three days old, was equal to 1·90 candles; and Gas No. 4, four days old, gave the light of 1·75 candles—these quantities representing the average of repeated trials.

It thus appears that the illuminating material of our coal gas is so rapidly abstracted by suffering it to remain in contact with water, that the same volume of gas which to-day will give me the light of nearly 11 candles by standing until to-morrow will give the light of only $3\frac{1}{2}$ candles, and if left standing four days will give the light of only $1\frac{3}{4}$ candles, while the only means left to the consumer to get the light he requires from this deteriorated gas is to burn more of it, as we have all been doing through the past winter. If we now take into account the well known fact that gas of less illuminating power has less density, and that gas of less density passes more rapidly through a given aperture than gas of greater density, we have another cause operating to increase the consumption. In Hedley's experiments the Argand burner which gave the light of 25 candles when supplied with 3 cubic feet per hour of gas from Welsh cannel coal, with a specific gravity of ·737, required no less than $7\frac{1}{2}$ cubic feet per hour to give the same light, from the same burner, when the gas was made from the Newcastle coal and had a specific gravity of only ·475.

Again, as we diminish the illuminating power of the gas we increase its heating power, and this necessarily brings with it a higher temperature given to the burners, a higher temperature given to the gas passing through them, and again an increased rapidity in the flow. It is thus manifest that the public are placed in a peculiarly unfortunate position, since all the mistakes that are likely to occur in the process of manufacture are mistakes that must inevitably increase the bills of the consumer and the profits of the manufacturer. If the workman fails to raise the heat with proper rapidity, if he overlooks a retort and allows the heat to continue a little too long, if towards the close he allows the heat to rise a little too high, the result is inevitable the product is deficient in illuminating power. Or if on any one day a little more gas is produced than is legitimately required, the surplus remains in the gasometer to vitiate the supply of to-

morrow. To what extent this vitiating action operates may be inferred from the fact that I have never been able to obtain from the gas of our pipes an illuminating power equal to the minimum of that reported by the engineer of the gas company. In my trials the power has varied from that of 13 candles down as low as that of 9 candles, instead of ranging from 14 to 17 candles.

This difference is perfectly intelligible if we assume the last quantities to represent the value of the gas when first made, and my results to represent its value as delivered to the consumer.

In conclusion I would merely add that the difficuly suggests its own remedy. And that would be to have a standard of quality established by the proper authorities, taking the illuminating power as the basis of the calculation, and then to have the requirements of such standard insured by a nightly examination, if necessary on the part of some one entirely disconnected with the manufacture. In other words the photometer can be made as available and as valuable to the consumer of gas as the hydrometer is to the spirit merchant; as he distinguishes with his instrument in any mixture, between the spirit he wishes to buy and the water he is unwilling to pay for, so the consumer of gas can distinguish with the photometer between the true illuminating material and the worthless heat producing gases, hydrogen and light curburetted hydrogen, that make up the bulk of the ordinary coal gas.

Art. XIV.—*On the Dynamical Condition of the Head of a Comet;* by Professor W. A. Norton.

It is proposed, in the present article, to give the mathematical theory of the development of the nebulous envelope of the head, and the tail of a comet from the nucleus; under the combined action of a repulsive force exerted by the nucleus, and a repulsive force exerted by the sun—each of these forces being supposed to vary inversely as the square of the distance from the centre of the repelling mass. So far as I am aware, no attempt has hitherto been made to develope the idea of a dynamical condition of the head of a comet into a mathematical theory, based upon precise numerical laws.

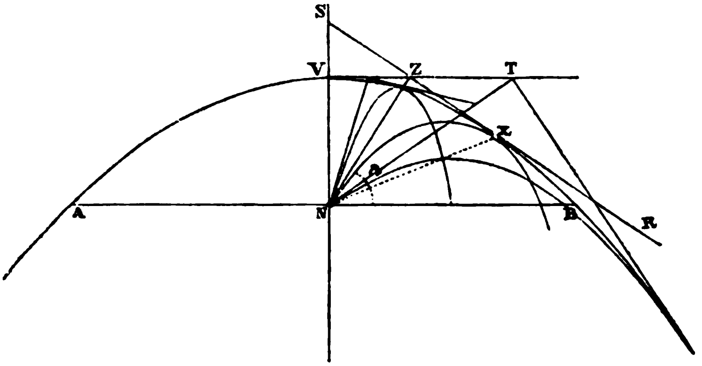
The hypothesis that a projectile force is in operation, combined with a repulsive action, or even with a gravitating force only, will also be briefly considered.

Let us first suppose cometic matter to be expelled from all points of the surface of the nucleus, on the side toward the sun, and in directions normal to the surface, regarded as spherical. As the nucleus is very small, in comparison with the nebulosity

of the head, the error will be slight if we regard it as a mere point, and conceive the nebulous matter to be repelled in all directions from this point. At the same time it must be observed that, for each expelled particle, the central point of repulsion is below the point of emission a distance equal to the radius of the nucleus. Again, as the rectilinear dimensions of the head of a comet are small as compared with its distance from the sun, we may, without material error for our present purpose, regard the repulsive force of the sun as constant.

Let N (fig. 1) be the nucleus, regarded as a point, NS the direction of the sun, and AB a line perpendicular to NS, which

1.



we will regard as the line of demarcation between the head and tail. Suppose a particle to be emitted in the direction NZ, and let the angle of projection, ZNB $= a$. Also let $p =$ acceleration due to excess of repulsion of nucleus over its attraction, at the surface of the nucleus; $k =$ opposing acceleration, from sun's repulsive force; and $r =$ radius of nucleus, or the distance of the point of emission from the centre of repulsion, wherever this may be. We will first undertake an approximate investigation, by disregarding the effect of the recess of the particle from the line NZ upon the repulsive force of the nucleus. This amounts to supposing that the centre of repulsion moves along a line perpendicular to NZ, at the same rate that the particle recedes from NZ.

Decompose the sun's repulsive force into two components,—the one along NZ, and the other perpendicular to it. The former will be $k \sin a$, and the latter $k \cos a$. Denoting by z the distance passed over by the receding particle, in the direction NZ, in any interval of time; and by v the velocity at that distance, we have,

$$\left(\frac{pr^2}{z^2} - k \sin a\right) dz = v dv.$$

Integrating, $$-\frac{pr^2}{z} - k\sin a.z + C = \frac{v^2}{2}.$$

If we suppose the initial velocity to be zero, $v=0$, when $z=r$, and

$$-\frac{pr^2}{r} - k\sin a.r + C = 0, \text{ or, } C = \frac{pr^2}{r} + k\sin a.$$

Whence, $$pr^2\left(\frac{1}{r}-\frac{1}{z}\right) - k\sin a\,(z-r) = \frac{v^2}{2}; \text{ or, } pr^2\left(\frac{z-r}{rz}\right) - k\sin a$$

$$(z-r) = \frac{v^2}{2} \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

Let Z= greatest distance passed over in the direction NZ, and we have $$\frac{pr}{Z} - k\sin a = 0; \text{ or, } Z = \frac{pr}{k\sin a} \quad . \quad . \quad (2)$$

This value of z is the distance NZ, X being the point where the orbit is tangent to the line ZX, perpendicular to NZ. Putting $a=90°$, we get for the distance to which a particle will recede from the nucleus, when emitted in the direction NS,

$$H = \frac{pr}{k} \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

But, by equ. (2), $Z\sin a = \frac{pr}{k} = H$; also $Z\sin a = Z\sin NZV = NV$; hence NV=H, and the point Z will fall on VT, drawn through V, at the distance H from N, and perpendicular to NS.

To find X, the point of tangency, resume equ. (1); and, since remote from the nucleus r may be neglected in comparison with z, we have $$\frac{dz^2}{dt^2} = v^2 = 2(pr - k\sin a.z) \quad . \quad . \quad (4)$$

Whence, $$dt = \frac{1}{\sqrt{2}} \cdot \frac{dz}{\sqrt{pr - k\sin a.z}} = \frac{1}{\sqrt{2pr}} \cdot \frac{dz}{\sqrt{1 - \frac{k\sin a}{pr}z}}$$

Integrating, $$t = \frac{1}{\sqrt{2pr}} \cdot \frac{\left(1 - \frac{k\sin a.z}{pr}\right)^{\frac{1}{2}}}{-\frac{1}{2}\,\frac{k\sin a}{pr}} + C$$

Or, reducing, $$t = -\frac{\sqrt{2pr - 2k\sin a.z}}{k\sin a} + C \quad . \quad . \quad (a)$$

This formula is quite accurate for determining any portion of the interval of time sought, for the beginning of which z is large in comparison with r, and as the motion is far more rapid in the vicinity of the nucleus than at a distance from it, we may obtain pretty nearly the whole interval of time, from N to X, by supposing z, at the beginning, to be several times r; but, on this

supposition the formula gives nearly the same value, as when z is made equal to zero. Therefore let $t=0$, when $z=0$, and we have

$$C=\frac{\sqrt{2pr}}{k\sin a};\ \text{and}$$

$$t=\frac{\sqrt{2pr}}{k\sin a}\left(1-\sqrt{1-\frac{k\sin a.z}{pr}}\right)\quad . \quad . \quad (5)$$

For the point X, $z=\dfrac{pr}{k\sin a}$, and $T=\dfrac{\sqrt{2pr}}{k\sin a}$ . . (6)

To verify this value of T, I have made another calculation, by dividing the time into two intervals. The first extends to the instant of time when the distance becomes equal to the $\sqrt{\dfrac{k}{p}}$ part of the whole distance, Z; during which the motion may be regarded as very nearly uniform, with an average velocity equal to $\sqrt{pr}$. The calculation for the remaining interval was made by the above equation (a). The result obtained is $T=\dfrac{\sqrt{2pr}}{k\sin a}\left(1+\dfrac{1}{5}\sqrt{\dfrac{k}{p}}\right)$. This differs from the above determination, by only $\dfrac{1}{85}$, in the case of the comet of 1811, and about $\dfrac{1}{20}$ in the instance of Donati's Comet.

To find ZX=X, we have $X=\frac{1}{2}k\cos a.T^2=\frac{1}{2}k\cos a\dfrac{2pr}{k^2\sin^2 a}=$
$\dfrac{pr\cos a}{k\sin^2 a}=\dfrac{pr}{k\sin a}.\cot a$ . . (7)

But $ZX=ZN\times\cot ZXN=\dfrac{pr}{k\sin a}.\cot ZXN$; hence $ZXN=a=$ ZNB=NSZ. (Fig. 1.) Thus NX=NS; and the point of tangency, X, of the path of any particle to the line ZR, lies in a parabola, which has N for its focus, and V for its vertex.

As the orbits of all the particles are tangent to this parabola, the paraboloid generated by revolving it about its axis will be, approximately, the bounding surface of the head of the comet.

To ascertain the form of the orbit traced, on the present supposition, by any particle, resume the value of t, as given by equ. (5); also take the value of t given by equation $x=\frac{1}{2}k\cos a.t^2$. We thus get

$$\frac{\sqrt{2pr}}{k\sin a}\left(1-\sqrt{1-\frac{k\sin a}{pr}z}\right)=\sqrt{\frac{2x}{k\cos a}}$$

Squaring, $\dfrac{2pr}{k^2\sin^2 a}\left(1-\sqrt{1-\dfrac{k\sin a}{pr}z}\right)=\dfrac{2x}{k\cos a}$ (approximately)

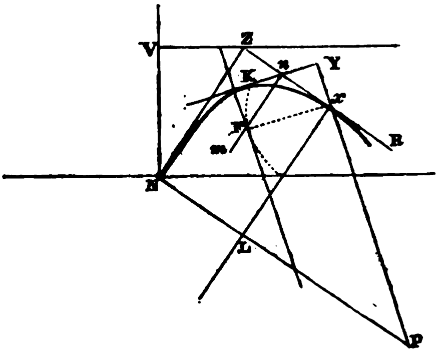
$$\text{Reducing, } \left(1 - \frac{k \sin{}^2 a}{pr \cos a} x\right)^2 = 1 - \frac{k \sin a}{pr} z$$

Transposing coordinates to point X, we have, $x = \frac{pr \cos a}{k \sin{}^2 a} - x'$,

and $z = \frac{pr}{k \sin a} - z'$; substituting and reducing,

$$\frac{k \sin a}{pr} \operatorname{tang.}^2 a . x'^2 = z', \text{ or, } x'^2 = \frac{pr}{k \sin a} \cot{}^2 a . z' \quad . \quad . \quad (8)$$

2.



This is the equation of a parabola; the diameter through X makes an angle β with XR (fig. 2) determined by the equation $\cot \beta = \frac{2X}{Z}$; or by laying off LP=2X, and joining P with X. The parameter of this diameter=X.cot a sin β.

To find the focus and vertex lay off on the diameter produced the distance $XY = \frac{\text{parameter}}{4} . \cos{}^2\beta$, draw YK perpendicular to the diameter; the vertex will be on this line. Through the point n where this line crosses the tangent XZ, draw nm perpendicular to XZ, and with a radius $= \frac{\text{parameter}}{4}$ describe a circle around X as a centre; the point F in which this circle cuts nm is the focus. Drawing FK parallel to XP, we have the axis and the vertex. The parameter of the axis $= X \cot a \sin \beta . \sin{}^2\beta = X \cot a \sin{}^3\beta = Z \cot{}^2 a \sin{}^3\beta$ (by equs. (2) and (7)).

In this investigation it is virtually supposed that the nucleus moves along the line NL, perpendicular to NZ, at the same rate that the particle recedes from NZ. This may seem to be a rough approximation except in the case of a large angle of emission; but, with a certain restriction soon to be stated, the results obtained are in fact a close approximation to the truth. The reason is that the repulsive force of the nucleus produces the greater part of its effect while the particle is in its vicinity, and at a distance from it, where the change of direction and the difference between NZ and NX has become considerable, it is exceedingly small in comparison with the sun's action. To test the accuracy of our results, let us investigate the distance that

the particle will recede in the direction NZ, upon a different and extreme hypothesis; viz., that it is projected from a point at a distance $2r$ from the centre of the nucleus, with a velocity equal to that acquired in passing from the distance r to the distance $2r$, and that the repulsion of the nucleus acts in the direction NX, which, as we have seen, is inclined to NZ under an angle equal to the complement of a. The differential equation for finding the velocity in the direction NZ, will be

$$\left(\frac{pr^2}{z^2}\sin a - k\sin a\right)dz = vdv.$$

Integrating, $\quad -\frac{pr^2}{z}\sin a - k\sin a \,.\, z + \mathrm{C} = \frac{v^2}{2}.$

Putting $\quad \mathrm{V} =$ velocity at distance $2r$,

$$\mathrm{C} = \frac{\mathrm{V}^2}{2} + \frac{pr^2}{2r}\sin a + k\sin a \,.\, 2r$$

Whence, $\quad \frac{v^2}{2} = k\sin a\,(2r - z) + pr^2\sin a\left(\frac{1}{2r} - \frac{1}{z}\right) + \frac{\mathrm{V}^2}{2} \quad . \quad . \quad (9)$

To find V^2, we have $v'\,dv' = \frac{pr^2}{z^2}dz$, or $\frac{v'^2}{2} = -\frac{pr^2}{z} + \mathrm{C}.$

$\mathrm{C} = \frac{pr^2}{r}$; thus $\frac{v'^2}{2} = pr^2\left(\frac{1}{r} - \frac{1}{z}\right)$. Which gives $\frac{\mathrm{V}^2}{2} = \frac{pr}{2}$, $\mathrm{V}^2 = pr$, and $\mathrm{V} = \sqrt{pr}.$

Substituting in equ. 9, we have

$$\frac{v^2}{2} = k\sin a\,(2\,r - z) - \frac{pr\,(2r - z)}{2z}\sin a + \frac{pr}{2}.$$

Putting second member $=0$, we obtain

$$\mathrm{Z} = \frac{pr}{k\sin a} - \frac{pr}{k\sin a}\cdot\frac{1}{2}(1 - \sin a)\ \text{(nearly)} \quad . \quad . \quad . \quad (10.)$$

The second term is small in comparison with the first, except for the smaller angles of emission. Taking $a = 45°$,

$$\mathrm{Z} = \frac{pr}{k\sin a} - 0{\cdot}14\,\frac{pr}{k\sin a}.$$

We accordingly have, in general, $\mathrm{Z} = \frac{pr}{k\sin a}$ (nearly). This is the same result that was obtained by the first investigation. That it can differ but little from the truth may be seen by comparing $\mathrm{V} = \sqrt{pr}$, with the greatest possible velocity that the repulsive energy of the nucleus could impart to a particle, if unopposed by any force, and acting through an infinitely great

distance. The expression for this maximum velocity is $\sqrt{2pr}$; greater than V only in the proportion of 7 to 5. At the point V (fig. 1) the repulsive force of the nucleus is less than that of the sun, in the same proportion that NV is less than r, the radius of the nucleus. In the case of the great comet of 1811 this ratio was nearly as 300 to 1. Unless a comet comes very near the sun, the repulsion of the nucleus, at the outer surface of the head, is therefore so small in comparison with the sun's repulsive energy, as scarcely to have any sensible effect.

We may therefore suppose that when any receding particle reaches the tangent point X, (fig. 2), it continues on its course, subject to the sun's action alone. The preceding investigation would not, in general, apply with sufficient accuracy to the orbit continued beyond this point. The trajectory that we readily obtain on the supposition just mentioned, becomes, however, materially modified when a returning particle passes in the vicinity of the nucleus. The repulsion of the nucleus will in this case deflect the particle into a curve convex to the nucleus. When the distance is too great for this effect to be produced, the repulsion will still have the effect to diminish, more or less, the curvature of the orbit.

The trajectory at the remoter distances from the nucleus may also be obtained, by the ordinary theory of projectiles, if we regard the particles as projected from the point where its orbit becomes parallel to AB, and with the velocity which it there has. As the angle of emission, a, becomes quite small, this conception would lead to less accurate results.

We have hitherto supposed the particle, emitted from the surface of the nucleus, to have no initial velocity. If we suppose it to be projected with any velocity V, this velocity may be regarded as having been acquired in moving from a point at a distance $\frac{r}{n}$ from the centre of the nucleus; and proceeding with the investigation as before, we obtain in place of equ. (2)

$$Z=n\frac{pr}{k\sin a} \quad . \quad . \quad . \quad (11)$$

From which it appears that the effect will be to increase the value of Z, in the ratio of n to 1; without, therefore altering the form of the head of the comet. The present supposition is equivalent to conceiving the nucleus to be concentrated into a sphere whose radius is $\frac{r}{n}$, and that the particle leaves its surface without initial velocity.

Let us now suppose, for the moment, that the particle is projected from the nucleus, and is subject only to the *attraction* of

the nucleus, and the repulsion of the sun. Let g = acceleration due attraction of nucleus, at its surface; or, what amounts essentially to the same, the excess of the attractive over the repulsive acceleration. We now obtain

$$Z = \frac{V^2}{2\,k \sin a} - \frac{gr}{k \sin a} \quad . \quad . \quad . \quad . \quad (12)$$

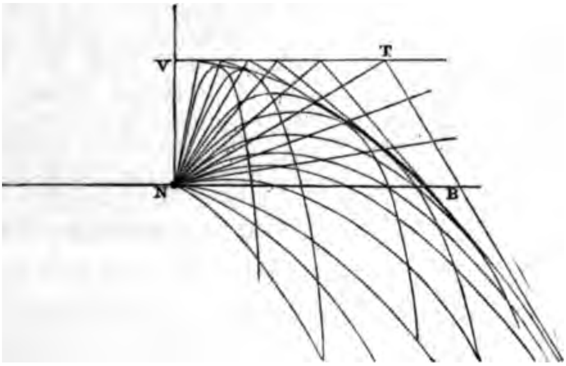
If we suppose $g = 0$, we have

$$Z = \frac{V^2}{2\,k \sin a} \quad . \quad . \quad . \quad . \quad (13)$$

which is of the same form as equ. (2).

In view of what has now been established we may conclude that, if the force of repulsion is of the same intensity, on all sides of the nucleus, the outer surface of the head of a comet differs but little from a paraboloid of revolution, having its focus at the nucleus and its vertex at the point V, (fig. 1) to which the particles are expelled in direct opposition to the sun's repulsive force. We see also that the paths of the individual particles are very nearly parabolas, having the positions and dimensions indicated on p. 90. Or at least this is sensibly true, from the nucleus to the tangent point X. Fig. 3 shows a number of these orbits, corresponding to various angles of emission.

3.



Such, on the present theory, is the actual limiting surface of the head. The form and extent of the surface, *as visible to the observer on the earth*, must differ more or less from this; for in the first place, at the actual boundary the line of sight touches the surface, and it is not until it falls within it and traverses a larger extent of luminous matter, that a sensible impression is made upon the eye. Again, the apparent form depends upon the obliquity to the axis under which the head is viewed..

Donati's comet, about Oct. 10th, was seen under favorable circumstances for observing the actual form of the head. The line of sight was then inclined under a large angle to the axis of the head and tail. The visible form of the head must also depend upon the various degrees of condensation, or closeness of proximity of the moving particles; and this is dependent upon the relative velocity of the particles following on after each other, and the proximity and intersections of the orbits of different particles. To illustrate, those particles which are ejected more in a direction toward the sun, have very small velocities at the turning points of their orbits; the particles are therefore crowded together there, and the visible surface should differ but little from that of the paraboloid, before mentioned. On the other hand the particles which are emitted from the sides of the nucleus, or under small angles, (a), are constantly moving with increasing velocity, and hence, those which follow each other, in the same path, must separate from one another as they recede. It is therefore only by the proximity and intersection of such separate orbits that the luminosity can be greater at some parts than at others. The tendency of this state of things will be to contract the lateral parts of the head; or in the direction NB, (fig. 3). The apparent surface of the head should therefore lie within the actual parabolic surface, and have the approximate form of an *ellipsoid*,—the form which Donati's comet presented.

A still greater deviation from the parabolic form would result if the energy of the repulsion should be less at the sides than at the anterior portion of the nucleus; or if, while the repulsion remained the same, the velocity of projection should decrease from the front of the nucleus where the sun is vertical.

If we suppose the repulsive acceleration of an emitted particle, to depend upon the action of the sun's rays upon the surface of the nucleus, and to be proportional to its intensity, then the distance to which it will be repelled, in the direction of emission, will be expressed by $\frac{pr}{k \sin a} \times \sin a$, or $\frac{pr}{k}$. On this hypothesis the form of the head would be nearly *circular*. The circular form has in fact often been observed (e. g. the semi-circular disc, or hood, resting upon the nucleus of Donati's comet, after its perihelion passage; also head of Halley's comet, on Oct. 29th, 1835).*

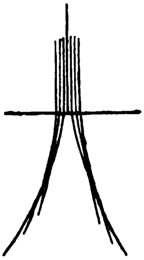
If we adopt the idea that the nucleus exercises no repulsive action; or that its repulsion, if any, is exceeded by its attraction, equ. (12), shows that the form of the head must still be parabolic.

* According to the subsequent theory of the sun's electric action the velocity of emission should, in general, be least at the sides of the nucleus. I conceive also that the repulsion should be least effective, as compared with the attraction, at the sides.

For the first term gives the parabolic form, and the subtractive term varies as $\frac{1}{\sin a}$, which is also the law of variation of the distance between two parabolas having a common focus and axis, estimated in a direction perpendicular to the tangent. The only essential difference between this case and that in which the repulsion is in excess, is that the returning particles which pass in the vicinity of the nucleus will now be attracted by it, and pursue paths more concave toward the nucleus, instead of convex.

A detailed discussion can therefore alone settle definitively the question between these two possible modes of development of the head of a comet from its nucleus. This must be left for another occasion. We will only call attention here to a remarkable luminous appearance that has occasionally been observed behind the nucleus of a comet (e. g. Comet of 1807), which seems to be a striking indication of the operation of a force of repulsion. It consists, apparently, of two jets of luminous matter, issuing from the nucleus, and convex toward each other, like the two branches of a hyperbola. Upon the theory of repulsion, it may be explained by the intersection of the orbits of particles that pass in the immediate vicinity of the nucleus. Those which make the closest approach to the nucleus, will be most deflected from their course. The consequence will be that the trajectory of each particle will intersect those of all the particles that come between it and the nucleus. This curious result is illustrated in fig. 4. It is a case similar to that of caustic curves in optics.

4.

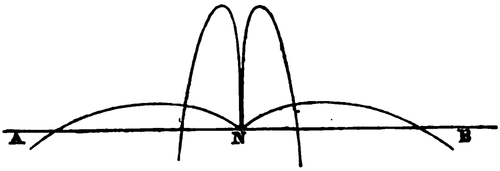


It will be seen on referring to fig. 3, that the particles which are emitted from the portion of the nucleus that lies nearest to the sun, on returning past it go to make up the body of the tail; while those which proceed from the lateral parts, as they are driven away by the sun, finally form the surface of the tail. We would here take occasion to observe that as the angle of emission becomes less, the orbits, as they traverse the head, and are about leaving it, lie nearer together; and rather suddenly separate from each other, when the angle becomes small. This fact is imperfectly indicated in fig. 3. It may be inferred from the fact that the parameter of the parabolic path of the particle continues to increase as the angle of projection diminishes, until it becomes quite small. The peculiarity here noticed affords an explanation of the sudden curved terminations of the luminous disc that formed the central portion of the head of Donati's Comet, as seen in telescopes in October; and of other similar luminous appearances (e. g. Halley's Comet as seen by Struve, Oct. 29th, 1835, and the same on Oct. 22). The natural result,

upon the normal condition of things, would seem to be modified and made more conspicuous, in some instances, by a sudden discontinuance, at a certain point on the side of the nucleus, of the ejection of luminous matter.

I have indicated on a previous occasion (in a paper read before the American Philosophical Society, in 1843) the cause of the curvature of the tail, and of the deviation of its general direction from direct opposition to the sun; on the theory of the particles being separately driven off by the repulsive force of the sun. The theory of the development of the tail is so intimately associated with that of the head—the two appearances being in fact but two different parts of one general phenomenon,—that it will be proper here to notice a particular phenomenon which appears to find its explanation in the views now presented. I allude to the fact so conspicuous in Donati's Comet, and before recognized as a general fact, that the preceding side of the tail was brighter and more distinctly defined than the following side. The phenomenon appears to result from the unequal velocities of different particles as they pass from the head into the tail. This explanation is illustrated in fig. 5. The particles which

5.



recede to a greater distance from the base, AB, of the head, pass it on their descent with much greater perpendicular velocity than those emitted under small angles from the nucleus, and attaining only to a small height above AB. The more rapidly moving particles go to the interior of the tail, the others to the marginal parts. Now the former will pursue a straighter course, as they move away from the head, and one which deviates less from direct opposition to the sun. They will, therefore, cross in succession, or crowd upon the lines pursued by the outer particles on the preceding side of the tail, and separate from those traced by the particles on the other side of the tail. This effect should be more marked as the comet recedes from the sun, and the initial velocity acquired by the central particles, becomes a larger fraction of the velocity imparted to them by the sun. It was finely observed, in the instance of Donati's Comet, about Oct. 10 and 11. As the comet receded from the earth and sun, became less distinct, and our line of sight became oblique to the plane of the orbit, the contrast was less conspicuous, and the wide dispersion of nebulous matter toward the end of the

ıg side of the tail was no longer noticed. Another cause eration, while a comet is receding from the sun, to pro- ə same results; the central particles, which we have seen ə greater velocity, were emitted from the nucleus before ırs which leave the base of the head at the same instant, ırefore arrive with a higher velocity in the direction of ıital motion of the nucleus. To these may be added possible cause, in occasional operation; viz: the more evolution of luminous matter on the forward side of the which, if the comet does not turn upon an axis, has ıgest exposed to the sun's action.

ıking confirmation of this explanation we have the fact in the case of Donati's Comet, and of comets generally, ə fainter secondary tails make their appearance at the side of the tail.

ınation of the observed variations in the size of the Nebulous ɛ of the Head of a Comet, as the Comet approaches and re- m the Sun.—Many of the variations noticed as having lace in the length and distinctness of the *tail* of a comet, əly apparent. For example, when a comet is at a great without the earth's orbit its tail is foreshortened; but, reason is more distinct than it would otherwise be. The he great comet of 1843 was also very much foreshortened 28th, when it was seen in open day; to which supposed ı attributed, in part, the great brilliancy of the comet :s orbit had been determined. But the variations in the ons of the head, to which we here allude are real, and if not universal. The facts noticed are that the nebu- ' the head contracts greatly as the comet approaches the l enlarges, in a corresponding degree, as it recedes from These curious and puzzling facts are but simple con- əs of the dynamical theory that has now been developed. rring to equ. (3) it will be seen that the repulsive force ıucleus exceeds that of the sun, at the distance of the in the ratio of the focal distance NV (fig. 1) to the ra- the nucleus. Unless, therefore the repulsion of the nu- ries with its distance from the sun, the ratio of these ıust vary inversely as the square of the distance from The focal distance and all the distances Z, given by should therefore both decrease and increase, according ıme law, as the comet approaches the sun, and recedes n again. The contractions, observed by Hevelius to take Encke's comet, in 1828, as it approached the sun, were :han would result from this cause alone. The enlarge- the envelope of Donati's comet was also, according to ısurements of G. P. Bond, Esq., of Harvard College Ob- y, more rapid than should have resulted simply from

the decrease in the sun's force. We must therefore conclude, from our present stand-point that the matter of the nebulosity is either repelled or projected from the nucleus with an intensity of force that decreases as the comet approaches the sun, and increases as it recedes from the sun. Variations in the amount of luminous matter ejected may also conspire with these variations of intensity of force, to give increased effect. The changes here supposed may seem to be contrary to what would naturally be expected; I can only say in the way of explanation, that they accord with the theoretical views which I have been led to adopt on other grounds, with regard to the process of evolution of nebulous matter from the nucleus, and the nature and origin of the repulsive action.

If we suppose, in the case of Encke's, and other similar comets, that the attraction of the nucleus exceeds its repulsion, the variations in the value of k, as the comet approaches the sun, and recedes from him, will still be attended with an alternate contraction and expansion of the nebulosity. But to explain the full amount of this change, we must suppose the projectile force to vary at the same time.

Determination of the Mass and Density of the Nucleus of a Comet. —If the force of repulsion which we have here considered as exerted both by the nucleus of a comet and the sun, be a property belonging alike to all the particles of the mass of each body, we have the means of readily determining the mass and average density of the nucleus. For equ. (3) makes known the ratio of p to k, and by the law of inverse squares, we may compute the ratio of k to the repulsive acceleration that has place at the sun's surface, which we will denote by K. We then have, to find the ratio of the masses of the sun and nucleus, the proportion

$$p : \mathrm{K} :: \frac{m}{r^2} : \frac{\mathrm{M}}{\mathrm{R}^2}$$

Which gives $\mathrm{M} = \frac{\mathrm{K}}{p} \cdot \frac{\mathrm{R}^2}{r^2} \cdot m$ . . . . . . (14)

I have made the computations for the comets named in the following table, which contains, also, the data used in the calculations.

Name and Date.	Diameter of Nucleus.	Distance N V (Fig. 1).	Distance from Sun.	Observer.
Donati's Comet; Oct. 5th,	400 miles	4410 miles	57,000,000 miles	Bond.
" " Oct. 6th,	800 "	5120 "	57,500,000 "	"
" " Oct. 8th,	1120 "	7720 "	58,500,000 "	"
First Comet of 1811; Oct. 6th,	428 "	63,500 "	106,000,000 "	Herschel.
Halley's Comet, 1835 ;Oct. 29th,	465 "	25,520 "	64,000,000 "	Struve.
Comet of 1799,	373 "	20,000 "	100,000,000 "	
Comet of 1807,	538 "	30,000 "	95,000,000 "	Herschel.

In the instances of the Comets of 1799 and 1807 the date of the measurements is not known, and accordingly the distance from the sun has only been roughly estimated. The distances given for the other comets are sufficiently close approximations for our present purpose. The true diameter of the nucleus of Donati's Comet cannot exceed 400 miles, as determined on Oct. 5th; but as it is possible that the cometic matter may be ejected from the surface of the apparent nucleus, the calculations have been made from the observed diameters. The results obtained by taking the diameter of nucleus at 400 miles are given at the bottom of the table.

The following table contains the results of the calculations:

Name.	Mass Compared with Sun.	Mass Compared with Earth.	Density (density of water=1.)
Donati's; Oct. 5th,	$\frac{1}{3,891,685,000}$	$\frac{1}{10,400}$	3·8
" Oct. 6th,	$\frac{1}{1,589,806,000}$	$\frac{1}{4,476}$	1·1
" Oct. 8th,	$\frac{1}{778,578,000}$	$\frac{1}{2,183}$	0·75
First Comet of 1811,	$\frac{1}{827,954,000}$	$\frac{1}{2,332}$	13·6
Halley's Comet,	$\frac{1}{690,493,000}$	$\frac{1}{1,945}$	12·6
Comet of 1799,	$\frac{1}{2,871,219,000}$	$\frac{1}{7,524}$	6·3
Comet of 1807,	$\frac{1}{1,136,885,000}$	$\frac{1}{3,202}$	5·0
Donati's; Oct. 6th,	$\frac{1}{3,179,612,000}$	$\frac{1}{8\ 956}$	4·4
" Oct. 8th,	$\frac{1}{2,180,018,400}$	$\frac{1}{6\ 154}$	5·9

The densities, although differing considerably among themselves, and possibly, as we shall soon see, too large, indicate that the nuclei of the larger comets are not made up entirely of vapor, or gas. The most probable inference to be drawn from them, is that the nucleus of a bright comet is a body of solid matter, like the earth, more or less covered with water, of which the greater portion is ordinarily in the condition of ice.

If the masses, as above determined, are too large to be admissible, we must then draw the theoretical inference that the matter expelled from the nucleus derives part of its velocity from a *force of projection*. That such a force of projection is in fact sometimes in operation, if the present theory be true, may be seen from the results given in the following table. The calculations are here made for the outer envelope; for which the values of NV were 321,500 miles and 20,000 miles.

Name and Date.	Mass compar'd with Sun.	Mass compar'd with Earth.	Density. (density of water=1)
First Comet, 1811, Oct. 6th,	$\frac{1}{163,598,000}$	$\frac{1}{461}$	68·5
Donati's, 1858, Oct. 2d,	$\frac{1}{758,215,000}$	$\frac{1}{2,136}$	18·7

A similar indication is afforded by the apparent increase in the mass of Donati's comet, from Oct. 5th to Oct. 6th, and 8th, as given in the former table.

When the nucleus appears to be surrounded by a spherical envelope, which is not continued into the tail, as in the case of the great comet of 1811, in the formation of this inner envelope the repulsion of the nucleus may possibly be inoperative, The mass of the nucleus may be determined on this supposition, only by assuming a value for v. We now have equation (12), which, by dividing by r, and taking $a = 90°$, gives,

$$\frac{H}{r} = \frac{V^2}{2kr} - \frac{g}{k}$$

Whence,

$$\frac{g}{k} = \frac{V^2}{2kr} - \frac{H}{r} \quad . \quad . \quad . \quad . \quad (15)$$

This equation gives the ratio of g to k, for any assumed value of V, and the ratio of k to the force of gravity of the sun is made known by the velocity imparted by k to the cometic matter flowing away in the tail of a comet. The calculation may also be made for any supposed value of V, in case the sun's repulsion is inoperative.

As we do not know to what extent a projectile force is in operation, we cannot be positive that the smallest masses and densities we have determined are not too large. In fact, by hypothetically increasing the initial velocity, and diminishing the repulsive force of the nucleus, we may reduce the mass and density to any extent. We may even suppose that the nucleus neither sensibly repels nor attracts the matter projected from it; and conceive the whole effect to result from the projectile force. The velocity of projection, on this supposition would be given by the equation,

$$v = \sqrt{2k\,(H - r)} \quad . \quad . \quad . \quad . \quad (16)$$

The approximate correspondence that obtains between the densities we have computed, lends support to the idea of a general cosmical repulsion, as a property of all particles of matter, and operating under special circumstances; since it accords with the notion, probable in itself, that the nucleus is made up of liquid, or of solid and liquid matter, like the earth. If subsequent calculations made for the other bright comets should give similar results, this inference would seem almost to be established.

Condition of the Nucleus—Evolution of Nebulous Matter.—On these topics there is only space to give a summary of the speculative notions I have formed. In the first place I conceive the telescopic nucleus of a large comet to consist of an atmosphere of aqueous vapor, or of a vaporous and gaseous atmosphere combined, condensed upon an inner nucleus more or less covered with water, or water partly in the condition of ice. In the case of the telescopic comets this central mass is probably altogether wanting. The vaporous atmosphere of the nucleus experiences vari-

ations of electric excitement under the influence of the sun;—after the same manner that the earth's atmosphere is effected by the sun. That an electric influence is directly exercised by the sun upon the upper regions of the earth's atmosphere, or the *photosphere* of the earth, appears to me to have been established in my later papers on Magnetic Variations, published in former Nos. of this Journal. When repeated electric discharges take place in the higher and rarified regions of the atmosphere of the comet, or of that of the earth, they must have the effect, according to the results of the recent experiments of M. Plücker, to arrange the vaporous matter in columnar masses, coinciding in direction with the lines of magnetic force. We thus have *auroral* columns in the comet's as in the earth's atmosphere. At the magnetic poles of the nucleus these would have a vertical position; and from these points would gradually decline from this position, until at the equator they would lie parallel to the surface. Now as a comet recedes from the sun its temperature falls, the suspended aqueous vapor begins to condense at certain depths in its atmosphere, the electricity thus set free flows in a series of electric discharges, which follow the course of the auroral columns, as soon as they are established. Condensations extending through a considerable vertical depth in the upper atmosphere, would also be attended with electric discharges from the one elevation to the other. It is these electric discharges along these auroral columns that, as I conceive, disengage the particles of aqueous vapor, or nebulous matter so called; and impel them off with a certain velocity. The same discharges bring the expelled particles into a condition to be repelled by the nucleus. How this result may be produced cannot here be adequately explained. As the temperature of the receding comet continues to fall, the process of condensation, and consequent evolution of aqueous vaper, goes on, and the visible nucleus increases in size. It would seem, from the observations of Mr. Bond, on Donati's comet, that large masses appeared to be disengaged at certain intervals. These phenomena may have arisen from the occasional suspension of the electric discharges taking place in the upper atmosphere. This would produce the appearance of the detachment and expulsion from the surface of the nucleus, of a ring of nebulous matter. Luminous phenomena, precisely similar to those here supposed take place in the upper atmosphere of the earth, to which we have given the name of *Aurora Borealis*, and *Aurora Australis;* and probably from the same cause. They are almost uninterrupted at the pole, during the long polar winter, and only at intervals display their coruscations in the skies of the temperate latitudes; where the changes of temperature are less, and the vaporous columns assume a more oblique position. On the other hand while a comet is approach-

ing the sun, its temperature rises, and at the same time its atmospheric electricity increases; condensations of aqueous vapor and their attendant electric discharges are now much less frequent. It thus happens that the evolution of vaporous matter, to form the head and tail, is much less copious before than after the perihelion passage; and increases in quantity for a certain interval of time after it. While these *auroral phenomena*, as they may be styled, are thus subject to great fluctuations, and to sudden interruptions, and are most prevalent in the polar regions* of the nucleus, there would seem also to be an uninterrupted electric discharge, from all points of the nucleus, turned toward the sun, continually detaching particles of aqueous vapor. This should be most abundant at the regions to which the sun is vertical, and where the electric excitement produced by it is the greatest; and may give rise to the hemispherical form of envelope, (see p. 94).

The phenomenon of separate concentric envelopes, or rings, often noticed, shows that the vaporous matter set free, at any time, is not all expelled to the same distance from the nucleus. This would be the case if we were looking down upon the polar regions of a comet whose axis was perpendicular to the plane of its orbit, and the matter was detached in zones from different latitudes. The statement here made will, perhaps, be better understood on glancing at the annexed figure. It would seem also that different intensities of electrical discharge should be attended with different velocities of projection. Upon the theoretical views I have formed these electic variations should also give rise to different intensities of repulsive action, as exerted by the nucleus. Again, if all the particles set free should not be of the same size, the smaller ones would experience the greater repulsive acceleration; provided the material repulsion is of the nature of an impulsive action against the surface of the particle.

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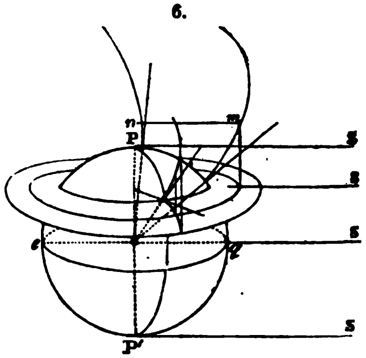

If the speculative notions just presented be correct, the question arises whether the earth may not be regarded, from our present point of view, as a comet; and if so, why do we not see its luminous train. The proper answer to this inquiry would

* It is to be observed that the motion of the nucleus in its orbit, occasions a virtual rotation around an axis perpendicular to the plane of the orbit; so far as exposure to the sun is concerned.

seem to be that the earth is actually, in a certain sense, a comet, and that its luminous train is seen by us in the Zodiacal Light. The nebulous earth-ring contended for by the Rev. Mr. Jones, in explanation of his admirable observations upon the zodiacal light, would seem then, in a modified sense, to have a real existence; instead of being in a condition of statical equilibrium, as supposed, it is in a dynamical condition of perpetual dispersion and renewal.*

Nor is the expulsion of vaporous matter into the surrounding regions of space confined to the nuclei of comets, and the earth. It occurs at the surface of the sun, and perhaps of all the heavenly bodies. It is beautifully seen, as a solar phenomenon, in a total eclipse of the sun; in the *corona*, or halo that encircles the sun concealed behind the dark body of the moon; the *aigrettes* that stream out in various directions, and perhaps also the *rose colored flames* that here and there project beyond the dim circular disc of the moon.

Note.—It would seem that even the visible nucleus of a comet is not in a truly statical condition. It contracts and enlarges with the varying distance from the sun. This may be a mere appearance, arising from the varying luminosity of the photosphere. It is also possible that the inner nucleus, with its atmosphere, may be surrounded by an ethereal atmosphere, which contracts and expands by reason of variations in an impulsive action of the sun, and in the density of the ether of space, in the vicinity of the sun. These remarks may also apply to the entire envelope of Encke's comet, and the complete spherical envelopes sometimes noticed, Spherical envelopes entirely surrounding the nucleus, would also be formed if the cometic matter should be projected from all parts of the nucleus with the same velocity, but with a force insufficient to overcome the gravitating tendency. An apparent spherical continuation of an envelope behind the nucleus, might, perhaps result from the intersections of the orbits of the cometary particles urged past it into space by the repulsive force of the sun.

A more accurate determination of the orbits of the cometic particles will be given in a succeeding No. of the Journal.

Art. XV.—*Review of Hall and Whitney's Report on the Geology of Iowa.*†

The first volume of the Report on the Geology of Iowa has just been published, and in a style highly honorable to the State. The State embraces much that is of scientific and practical interest, and Professors Hall and Whitney who have had the survey in hand, have accomplished great results considering the time afforded for exploration. The Carboniferous formation is a prominent feature in the geology, and has afforded a splendid collection of

* The vaporous matter which is incessantly streaming off from the sun into remote space, should enhance the brightness of the zodiacal light.

† Report on the Geological Survey of the State of Iowa: embracing the results of investigations made during portions of the years 1855, 56 and 57. By James Hall, State Geologist, and J. D. Whitney, Chemist and Mineralogist. Published by authority of the Legislature of Iowa. Vol. I. pp. 724. 1858.

Crinoids for description and illustration. Even the Permian has some representative beds, though discovered too recently—the Introduction states, after the Permian fossils of Kansas had been made known—to be described in detail in this volume. Prof. J. D. Whitney contributes chapters on the Physical Geography, Geology, and Chemical and Economical Geology including Mines,—Prof. Hall, on the General Geology and Palæontology, and A. H. Worthen, (Assistant,) on the Geology of the Des Moines valley and some other parts of the State.

The geological investigations have thus far been confined to the eastern half of the State, the western portion of Iowa, which is equal in area to New York, Massachusetts, Connecticut and Rhode Island put together, not having yet been examined. The work is divided into eight chapters, or divisions, of which the first is devoted to the Physical Geography, the second to some general remarks on the Geology of the Northwest, the third to a review of the Geological formations occurring in Iowa, as exhibited in a section on the Mississippi river, the fourth, fifth and sixth to the detailed Geology by counties, the seventh to the Economical Geology, and the eighth to the Palæontology, the whole work being comprised in 724 pages, with 29 steel and lithographic plates of fossils, a geological map and a diagram of the leadbearing crevices near Dubuque.

In Chapter I, we have a concise view of the topography of Iowa. The State is a vast plain, gradually rising as we proceed from the east towards the west, and from the south, northwards:—the absolute elevations are given from the railroad surveys, when such could be obtained. In this plain the streams have cut deep and narrow valleys, which are bordered by precipitous "bluffs," as they are termed, the river-bottom, bluff and prairie being the three conspicuous features of the topography of the State. The height and steepness of the bluffs decrease gradually from the north towards the south. The course of the tributaries of the two great rivers forming the eastern and western boundaries of the State, the Mississippi and Missouri, is adduced as evidence of the direction of the drainage having been determined by two sets of low and narrow flexures of the strata, one set running in a northwest and southeast direction and the other nearly at right angles to this. The Wapsepinicon is mentioned as a remarkable instance illustrative of this; this river having a length of about 250 miles and draining a valley which is only from eight to twelve miles in width. The "mounds" which break the monotony of the landscape in the lead region, are described as outliers of Niagara limestone, overlying strata of the Hudson river group, and rising in isolated, flat-topped hills, presenting evidence of extensive denundation. These mounds are from 400 to 600 feet above the Mississippi river, and about 200 above the general evel of the prairie at their bases.

The prairies, those wonderful treeless and fertile plains, the most marked feature of the Northwest, are described and the subject of their origin, a much controverted question, is briefly discussed. The theories which have, at different times been brought forward to account for the absence of trees in the prairie region are discussed and pronounced to be inadequate. It is attempted in the report to show that the extreme fineness of the particles of which the soil is made up is the predominating cause of this peculiar condition of the vegetation, and some facts are stated which go to confirm this theory. Reasoning from analogy of the smaller prairies to the thickly wooded region of the Upper Peninsula of Michigan, it is inferred; "that the whole region now occupied by the prairies of the Northwest was once an immense lake, in whose basin sediment of an almost impalpable fineness gradually accumulated, under conditions, the discussion of which is postponed to another volume in which the drift phenomena of the Northwest will be taken up; that this basin was drained by the elevation of the whole region, but, at first, so slowly, that the finer particles of the superficial deposits were not washed away, but allowed to remain where they were originally deposited. After the more elevated portion of the former prairies had been laid bare, the drainage becoming concentrated in narrower channels, the current thus produced, aided perhaps by a more rapid rise of the region, acquired sufficent velocity to wear down through the finer material on the surface, wash away a portion of it altogether, and mix the rest so effectually with the underlying drift materials, or with abraded fragments of the rock in place, as to give rise to a different character of soil in the valleys from that of the elevated land. This valley soil, being much less homogeneous in its composition, and containing a larger proportion of coarse materials than that of the uplands, seems to have been adapted to the growth of forest vegetation; and in consequence of this, we find such localities covered with an abundant growth of timber."

"Wherever there has been a variation from the usual conditions of soil, on the prairie or in the river-bottom, there is a corresponding change in the character of the vegetation. Thus, on the prairies we sometimes meet with ridges of coarse material, apparently deposits of drift, on which from some local cause, there has never been an accumulation of fine sediment: in such localities we invariably find a growth of timber. This is the origin of the groves scattered over the prairies, for whose isolated position and peculiar circumstances of growth we are unable to account in any other way."

At the close of the chapter on Physical Geography, a review is given of the meteorological observations which have been made in different parts of the State by different observers. From

a comparison of these some light is thrown on another question which has been discussed without having been satisfactorily answered, namely: What is the difference between the climate of the Eastern and Western States on the same parallel? It appears that while there is but little difference in the mean temperature of the *year* on the Atlantic coast and in the Mississippi valley, in the same latitude, there is a perceptible tendency to extremes in the mean of the *seasons*, the summers being hotter and the winters colder, as we go farther west. The annexed table (from p. 33) will serve to illustrate this statement.

Locality,	Latitude.	Year.	Spring.	Temperatures. Summer.	Autumn.	Winter.
West Point, N. Y.	41° 23′	50°·7	48·7	71·3	53·2	29·7
Fort Armstrong, Ill.,	41 30	50 ·3	50·5	74·1	51·7	24·9
Council Bluffs,	41 30	49 ·3	49·3	74·7	51·4	21·7
Utica, N. Y.,	43 06	45 ·7	44·5	66·5	47·3	24·5
Prairie du Chien,	43 05	47 ·6	48·7	72·3	48·3	21·2
Potsdam, N. Y.,	44 40	43 ·6	42·9	66·3	45·4	19·8
Fort Snelling, Min.,	44 53	44 ·6	45·6	70·6	45·9	16·1

In the geological portion of the Report, we notice the following matters as of more especial interest.

The members of the geological series developed in Eastern Iowa, all belong to the Palæozoic system, and include groups of strata from the Potsdam Sandstone up to the coal measures. The existence of the Permian in the central portion of the state is inferred from the presence of large masses of gypsum overlying the coal measures, but in connection with which no fossils have as yet been discovered. The range and extent of the formations is exhibited on the geological map accompanying the Report, a glance at which will be more satisfactory than an attempt at description. It may simply be noted that the general trend of the formation is northwest and southeast, and that the dip being to the south and west, the traveller, in passing over the State from northeast to southwest, crosses successively higher groups. There appears to have been but little disturbance of the strata since their deposition, and no igneous or metamorphic rocks are known to exist within the limits of the State.

The Silurian series, as it is developed in the Northwest, is made up of alternations of sandstones, dolomites, limestones, and shells. The order of succession, lithological character and thickness of the different members which are recognized in Iowa, may be seen in the annexed table, arranged in an ascending order:

Name of Group.	Lithological character.	Thickness.
Potsdam Sandstone,	Pure silicious sandstone,	250–300 feet.
Lower Magnesian Limestone, (Calciferous Sandstone of N. Y. Rept.)	Dolomite,	250 "
Upper, or St. Peter's Limestone,	Pure silicious sandstone,	80 "
Trenton, or Blue Limestone,	Alternation of slightly argillaceous limestones and shells, with pure limestones,	100–120 "

Name of Group.	Lithological character.	Thickness.
Galena Limestone,	Dolomite,	250–300 feet.
Hudson River Group,	Impure silicious shells and thin limestone bands,	80–100 "
Niagara,	Dolomite,	250–300 "
Le Claire Limestone, not recognized except on the Mississippi river,	Dolomite,	?
Onondaga Salt Group,	Dolomite, a few thin outliers, only recognized on the Miss. river.	

In general there is shown a thinning of the members above the calciferous sandstone as compared with the series in New York, and a disappearance of some of them. A few particulars with regard to the various groups are here added.

Potsdam Sandstone.—The very great thickness of this formation, which has been shown to exist in the Lake Superior region, is limited to the vicinity of the trappean rocks. Proceeding southwesterly from the copper-bearing range, we soon find the conglomerate to have disappeared, and have no evidence in Iowa and southern Wisconsin of the existence of more than 400 feet at any one point, while the mean development is probably not over 250 or 300 feet. The exposures of this rock are very limited in Iowa, but it covers considerable surface in Minnesota, and still more in central Wisconsin. Bands or intercalated masses of conglomerate are almost entirely wanting in the sandstone; these, as well as the lines of oblique lamination, appear to be confined to the vicinity of the igneous rocks. There is no member of the series more persistent, both in lithological and palæontological characters in the lower sandstone; it has been traced from lon. 73° to lon. 104°, exhibiting everywhere the same granular silicious character and characterized by the same organic forms, and we have, up to this time, no evidence of the existence of organic remains below this formation.

Lower Magnesian Limestone.—This is a mass of dolomite, having a thickness of from 225 to 250 feet, about 200 of which are nearly pure, crystalline dolomite, containing from one to ten per cent. of silicious sand, mechanically intermixed; the remaining 25–50 feet are beds of passage into the sandstone below, consisting of mingled and alternating sandstone and dolomite. Fossils are extremely rare in this member of the series; a few have been observed in Wisconsin in a very imperfect state of preservation, but none in Iowa.

Upper or St. Peter's Sandstone.—This repetition of the sandstone underlying the lower magnesian, is also remarkable for its persistence in lithological character and thickness over a great extent of surface. From La Salle, in Illinois, where it makes its appearance in a low axis of elevation, underlying the coal-measures unconformably, to St. Paul in Minnesota, a distance of over 400 miles, this sandstone hardly varies more than ten feet from its normal thickness of about 80 feet, which indicates a remark-

able uniformity in the physical conditions prevailing at the time of deposition of this comparatively thin mass. The fact that this sandstone is so persistent in its thickness and lithological character; that it consists of almost chemically pure quartz, in the form of grains of minute, but uniform size, with crystalline facets; that it contains no pebbles or fragments which can be recognized unmistakably as being of foreign or detrital origin, are noticed as giving plausibility to the supposition that it was a chemical precipitate, rather than the result of the mechanical disaggregation of pre-existing quartzose rocks. No fossils have been found in this sandstone.

Trenton Limestone.—Under this head is designated the series of beds between the Upper Sandstone and the Galena limestone, which may be subdivided into two portions: *a*, the buff limestone, an impure dolomite, containing from ten to twenty per cent of sand and clay; it is from fifteen to twenty feet thick, and is, in the vicinity of the Mississippi river, quite destitute of fossils. It is succeeded, in the ascending order, by *b*, the blue or Trenton limestone proper, a series of calcareous and calcareo-argillaceous layers, lime unaccompanied by magnesia appearing here for the first time in the series, the whole having a thickness of from 70 to 80 feet. For the first time, also, we find traces of organic life abundantly disseminated through the rocks, a fact not without significance in its relations to the absence of magnesia noticed above. Many of the layers, and shaly partings between the compact calcareous beds, are crowded with forms either identical with, or closely allied to, those which characterize the Trenton limestone in its extension from New York through Canada and on the northern shores of Lakes Huron and Michigan, and as far west as the Mississippi, along a line of outcrop some 1500 miles in extent.

Galena Limestone.—The passage from the Trenton limestone into the next succeeding member of the series, the Galena limestone, is not an abrupt one; on the contrary, there are, in many localities, several alternations of calcareo-magnesian and purely calcareous layers, indicating that the change of conditions which resulted in the deposition of the highly crystalline dolomite which overlies the Trenton was not effected at once, nor without occasional partial returns to the former state of things. The Galena limestone, as usually developed, is a rather thick-bedded, light greyish, or light yellowish grey, dolomite, distinctly crystalline in its texture and usually rather coarse-grained. The more crystalline portions frequently contain cavities lined with small crystals of brown spar, and the rock is remarkable for the irregularity with which it weathers, leaving picturesque outliers, with castellated forms, like watch-towers, or the half-ruined walls of ancient fortified cities. The quantity of insoluble matter in

this dolomite is very small, not usually exceeding two or three per cent; it consists almost entirely of quartzose sand. The fossils of the Galena limestone are closely allied to those of the Trenton, although, in the lead-region, certain ones, such as the *Receptaculites* and *Lingula quadrata*, which are characteristic of the Galena limestone, are not found in the underlying blue. The fossils of the Galena are all in the form of casts with the exception of those in which the shell originally consisted of *phosphate* of lime instead of the *carbonate*, as was the case with the *Lingula*; it appears, therefore, that the chemical changes which the rock has undergone since its deposition have been such as to remove the substance of shells consisting of the carbonate of lime, but to leave the phosphate untouched. Another interesting fact in connection with the palæontology of the Galena limestone is, the discovery in it of a single specimen of *Halysites catenulatus*, the characteristic and most abundant fossil of the Niagara limestone in this region. This coral was in the form of a cast, while those of the Niagara are uniformly silicified, this, with other circumstances, removing all possibility of error in regard to its true locality. A single specimen of the same genus is described by Mr. Hall as occurring in the Hudson river group on Green Bay, these two being the only instances in which this genus has been found in the United States in Lower Silurian rocks.

The Galena limestone forms a very important member of the series in the Upper Mississippi valley and in Wisconsin, although not distinctly recognized to the eastward of the Menomonee river; it is fully 250 feet thick in the vicinity of Dubuque, where it has its maximum development, and from which point it gradually thins out in every direction. It is, economically, of high interest, from the fact of its being the chief repository of the lead ore which has been, and still is, so extensively mined in the Upper Mississippi lead-region.

Hudson River Group.—This member of the series according to the Report is first distinctly recognized in its extension west of Little Bay des Noquets. Being composed chiefly of silicious and silico-argillaceous shales, which disintegrate with rapidity, so that a good natural section is rarely exposed, its existence in the Upper Mississippi valley was for a long time overlooked, although many of the shafts in the lead region are sunk through a greater or less thickness of it, in order to reach the underlying limestone. It did not escape the observing eye of Percival, who mentions it in his first annual Report, dated 1855, under the name of "Blue Shale," but without any indication of its palæontological relation or thickness, as, indeed, it has, within the limits of the lead-region in Wisconsin, been almost entirely removed by denudation. The thickness of these shales, when fully developed is from 60 to 80 feet, and in some places perhaps, as much as

100, but no natural section has been observed exposing more than 25. The quantity of organic remains crowded into some of the layers of this group, is truly astonishing; some strata of six or eight inches in thickness are made up of Orthocerata packed as closely together as they can lie. The palæontology of this formation has not been investigated in detail, but its position and the general character of its fossils leave no doubt of its equivalency with the Hudson river group.

An interesting fact in connection with these shales, is the large amount of bituminous matter which they contain, and which is shown in this Report to be characteristic of this group from New York, through Canada, to the Mississippi river. A specimen of a dark chocolate-colored shale from Savannah, Ill., was found to contain 20·96 per cent of combustible substances: other specimens from the vicinity of Dubuque, lost, on ignition, from 11 to 16 per cent. of organic matter. The black, highly-glazed and apparently very carbonaceous shales of the Hudson river valley, which have been so frequently mistaken for coal, contain from one-half to one per cent of carbon, but no volatile matter; while specimens of the Utica shale from Herkimer Co., on the other hand, lost from 12 to 14 per cent of their weight when burned in oxygen.

The presence of carbon in the shales of the Hudson river group over so extensive a region, and in so large quantity, is not only a matter of very considerable economical importance, as indicating a source from which, in those parts of the country where the true Carboniferous rocks are wanting, a supply of material for lighting, and perhaps heating, purposes may be obtained; but it is also of great interest in a theoretical point of view, as bearing on the question of the origin of the carbon in the coal-measures themselves. These shales and slates seem to have been accumulated under conditions somewhat resembling those which prevailed during the deposition of the Carboniferous series, while the presence of so large a per-centage of carbon in them is rendered still more striking by the fact, that, in the Northwest, neither the rocks below, nor those above as far up as the coal-measures, contain more than the merest trace of carbonaceous matter. From the base of the Potsdam to the top of the Galena limestone, the whole amount of carbon present in the rocks, would not, if collected into one layer, make a deposit of more than an inch or two in thickness; but if the bituminous matter of the Hudson river shales at Savannah, were all collected by itself in one stratum, instead of being diffused through perhaps 60 or 80 feet of shale, that stratum would have perhaps equalled twenty feet or more in thickness. A further investigation into the exact nature and distribution of the bituminous matter is contemplated.

Niagara Limestone.—This is the third great mass of dolomite, which, throughout the valley of the Upper Mississippi, lies next above the Hudson river shales, and which, as well from the extent of surface covered by it as from its thickness and persistency of lithological and palæontological characters, forms one of the most important members of the Silurian series in the Northwest. It is one of the rocks which, prior to the recognition of the Hudson river shales in the Northwestern mineral region, was included under the designation of "Cliff limestone;" and, more recently, has been described as the "Coralline and Pentamerus beds of the Upper Magnesian limestone,"—the term "Upper Magnesian limestone," according to Dr. Owen, including all the members of the series from the base of the Galena, up to the base of the Hamilton group. The Niagara limestone of the region in question is a nearly pure dolomite having a crystalline structure and a light yellowish gray color; it differs but little in external appearance from the Galena limestone, and hand-specimens of the two rocks might frequently be mistaken for each other. The Niagara limestone, however, does not often exhibit that tendency to irregular decomposition, and consequent weathering in fantastic forms, so characteristic of the Galena; it also contains a greater amount of silica in the form of layers and nodules of flint, and it differs from this last mentioned rock also, in the fact that the fossils it contains are usually silicified, and not preserved in the form of casts simply. It may also be noticed that, whereas in the Lower Magnesian and Galena groups the amount of magnesia present is almost exactly that required to form with the lime and carbonic acid, the double carbonate, or dolomite; in the Niagara, on the other hand, there is frequently a small excess of lime over the magnesia. The thickness of this member of the series is estimated at about 350 feet, 250 feet being the greatest amount measured in any one exposure. The Niagara limestone throughout the Northwest is marked by the presence of beds crowded with the *Pentamerus oblongus*, as also by numerous corals, of which *Halysites*, *Favosites*, *Heliolites*, *Syringopora* and *Lyellia* are the most conspicuous genera. There are also numerous Crinoids identical with, or closely allied to, those of the Niagara limestone of New York, but mostly in a very bad state of preservation, as might be expected in a crystalline dolomite.

Le Claire Limestone.—Of the groups recognized, in New York, as intermediate between the Niagara and the base of the Devonian, but a meagre representation has been observed in Iowa, and that only on the Mississippi river. The Le Claire limestone is described by Mr. Hall as a very heavy bed of dolomite, several hundred feet in thickness, which, in consequence of its disturbed condition and enduring character, has been the cause of the

Upper Rapids of the Mississippi. The fossils in it are all in the form of casts, and among them are, a small *Spirifer*, a *Spirigera*, a *Pentamerus*, undistinguishable from *P. occidentalis*, several Gasteropods and some chambered shells. This dolomitic mass is placed, conjecturally, on a parallel with the Galt limestone of Upper Canada, hitherto supposed to form the base of the Onondaga Salt Group. The Le Claire limestone has not been traced to any distance from the river, and is certainly wanting in north-eastern Iowa, where the Niagara limestone is overlaid directly by rocks of the Hamilton group. It appears that a further examination should be made of the section at the Upper Rapids, as it is difficult to understand how so thick a mass of rock should appear and disappear without having been recognized anywhere except at that one point.

The Onondaga Salt Group, a member of the Silurian series of so much economical importance in New York, is represented in the Mississippi river section by a few feet only of magnesian limestone, or nearly pure dolomite, although soft and destitute of crystalline structure. The peculiar physical condition of the Onondaga Salt Group, as it exists in New York, is exhibited in some of the layers of the section on Quarry creek, a small tributary of the Mississippi, but the economically valuable minerals are wanting. This group has not been traced west of the Mississippi, where, indeed, it exists only in a few detached fragments.

Of the rocks of Devonian age, the *Upper Helderberg Limestone*, so well marked in New York and Ohio, is with difficulty to be recognized to the west of the Mississippi. Certain non-fossiliferous strata cropping out on the bank of that river, at, and for two or three miles above, Davenport, are referred by Mr. Hall to that group, chiefly, as it appears, from their stratigraphical position and lithological character.

The Hamilton group is an important member of the series in Iowa, covering many hundred square miles of surface, although greatly diminished in thickness from what it was in New York. It consists of a series of purely calcareous and calcareo-magnesian strata, with occasional bands in which argillaceous matter occurs to some extent, the lithological character of this portion of the series being somewhat more variable than that of the groups below. The greatest thickness of this group exposed in any one section appears to be about one hundred feet; but its entire development has not been satisfactorily ascertained. A few of the species of fossils found in it are identical with those occuring in New York; but most of them are new. Several are more like Devonian species of Central Europe than any which had been previously described from this continent.

The Chemung group in the Mississippi valley gives but a meagre representation of the same series of rocks in New York, Pennsylvania and Ohio. It contains almost an entirely new Fauna, although of species closely allied to those of more easterly localities of the same group.

The passage from the Devonian to the *Carboniferous series* is shown, in this Report, to be an almost imperceptible one, both in the physical and palæontological character of the groups, there being no strong line of demarcation separating the upper calcareous beds of the Chemung group from the Burlington limestone, the lowest member of the Carboniferous limestone series.

One of the most interesting facts brought out in this connection, is the existence of five distinct members of the Carboniferous limestone series. These are shown to have been deposited in an ocean which was gradually contracting its limits on the north, the greatest development of each successive member of the series, in an ascending order, being to the south of the one below it; while, subsequent to the deposition of all these and the sandstone which separates the fourth and fifth limestones, the entire area was submerged, allowing the coal-measures to be deposited on the slightly inclined edges of all these limestones, as well as of the Chemung and Hamilton rocks, and also, to some extent of the Silurian limestone, after they had been disturbed and denuded.* All these limestones of the carboniferous series are well characterized by the fossils they contain.

The fossils of the survey are described and figured in Part II on Palæontology, by Prof. Hall, this portion of the volume extending to 250 pages. The Devonian and Carboniferous series have been selected for illustration, as the Silurian had previously received much attention in the Reports of Dr. Owen. In the Hamilton and Chemung groups the fossils are particularly interesting, as exhibiting the influence of geographical conditions, or of distance, while the physical condition remained nearly the same as in central and western New York. The entire number of species described from all these rocks is about 250.

Special attention is given in the Report to the fossils of the Carboniferous limestones, as illustrating the successive members of the series; and with this object contrasting forms have not been selected, but, on the contrary, the more common and characteristic fossils of each rock. Many hitherto believed to be identical with European species are proved to be quite distinct.

The number of species of Crinoids, described in the volume, is probably equal to or greater than all those before made known

* See this Journal, [2], xxiii, 187.

from the same formations. Those of the Carboniferous lime-stones amount to one hundred and seventeen species, and of these *eighty-nine* are new or not before described.

The true generic characters of *Zeacrinus*, *Agaricocrinus* and *Agassizocrinus* of Troost,—genera which that author had given in his catalogue, but of which he had never published the full descriptions—are here for the first time given. In this and other cases Mr. Hall has evidently aimed to recognise fully the unpublished labors of Prof. Troost. He has on page 544 the following note:—

"I have transcribed these observations, as well as the specific description of this species, from the MS. of Dr. TROOST'S memoir upon the Crinoideæ, which is to be published in the Smithsonian Contributions to Knowledge; having been permitted to make such references and citations as would enable me to verify any of the genera and species which I might describe in the Iowa Report. By this means, although Dr. TROOST'S paper has not yet been published, he has the precedence which belongs to him."

The *Scaphiocrinus* in its typical species so nearly resembles the *Graphiocrinus* of De Koninck and Le Hon that Mr. Hall is led to suspect that they have overlooked a series of small basal plates. These characters are here illustrated; and in the *Forbesiocrinus* is shown a series of three basal plates below the five plates supposed by these authors to constitute the base. This genus is further sustained by five American species, all of which are new.

Some interesting facts are shown, for the first time, connected with the structure of the *Actinocrinus*, and particularly the distribution of the arms and their relations to the rays or radial series of the plates of the body. These relations, as well as other important points for the discrimination of species are shown in the diagrams accompanying many of the descriptions with a formula of numbers belonging respectively to the anterior, antero-lateral and postero-lateral rays. These characters, shown to be constant, offer important additional facilities for the determination of species, especially where specimens are imperfect.

Of the genus *Actinocrinus* alone twenty-nine new species and two varieties are described, and of the genus *Platycrinus* sixteen new species. *Rhodocrinus* is noticed for the first time among American Carboniferous species. Five species of the genus *Archæocidaris* are described and illustrated, one from each of the limestones of the Carboniferous series.

This Report is doubtless the best contribution yet made to our knowledge of the Crinoids and other Echinoderms of the Carboniferous system; and, both as regards their structure and their geological distribution, it is of the highest interest. We might cite at length important observations on the genera and species,

did space allow. The plates are all good, and those of Crinoids remarkably beautiful and effective.

In the chapter devoted to Economical Geology, we find a large number of analyses of the rocks, coals, and other materials of economical value occurring in Eastern Iowa. The limestones analyzed are many of them almost chemically pure dolomites; and, in general, the predominance of crystalline carbonates of lime and magnesia over the purely detrital rocks is very marked all through the series. There is a striking deficiency of the argillaceous element, especially, in all the Silurian rocks. The analyses, taken together, exhibit a tendency, as we rise in the geological scale, to a greater variety of lithological character in the members of the successive groups, a greater amount of detrital matter and a diminution in the quantity of magnesia, there being no heavy and persistent bed of dolomite above the Silurian.

Among all the specimens examined, the only ones found to contain a sufficient quantity of insoluble matter to be available for hydraulic lime are those from the Buff limestone, at the base of the Trenton. It remains to be ascertained, by practical trials, how far the dolomites and highly magnesian limestones, with but a small quantity of insoluble matter, can be used for hydraulic purposes, as they have been to a limited extent in Virginia and also in France.

The analyses of numerous samples of coal show that they belong, like all the Western coals, to the highly bituminous class; they contain from 35 to 40 per cent of bituminous matter, and from 45 to 50 of fixed carbon. They all appear to hold a large amount of hygrometric moisture with great tenacity, parting with it slowly, and not until after years of exposure to a dry atmosphere. Some samples give as much as fifteen per cent of water, expelled by drying at a temperature of 212° F. Sulphur is present in all these coals, in a form not perceptible to the eye, to the amount of from one-half of one to two per cent, and also in much larger quantity, in combination with iron and lime, as pyrites and gypsum, which substances materially impair the value of western coals. No workable iron-ore of any importance has been discovered in connection with the coal-measures of Iowa, which are exceedingly thin, no section having been measured in the Des Moines valley giving much over a hundred feet in thickness.

The subject of the occurrence of the lead ore in the Lower Silurian limestones of the Upper Mississippi valley, and, especially, within the limits of Iowa, is discussed in this Report on pages 422 to 468. The principal crevices, or lead-bearing fissures, which have been worked in the vicinity of Dubuque are described, and a diagram given illustrating their surface-

arrangement, so far as could be made out from the information collected. In no part of the lead region are the crevices developed on a more extensive scale, or with so much regularity, as in the Dubuque district. The characteristic form of occurrence of the ore is the *cave-opening,* or expansion of the vertical crevice into a cave or chamber, whose walls are sometimes lined with a heavy incrustation of pure galena, but which are more generally partially filled with clay and loose masses of rock, mixed with fragments of ore, derived from the decomposition of the material which once filled the *opening*, or metalliferous portion of the rock. Some of these caves have yielded several millions of pounds of galena, from a space very limited in depth and length.

It is a favorite idea among those who have little acquaintance with mining operations in general, or who wish to dispose of abandoned lead-mines to Eastern capitalists, that the lead crevices extend indefinitely downwards, and that the only reason why deep mining has not been carried on in this region is that the miners have not sufficient skill or capital to work down to any considerable depth. It has also been insisted on by the same class of persons, that the Lower Magnesian limestone is a good mineral-bearing rock, and that lead-mining may be carried on in it with profit, while the expediency of sinking shafts through the Upper Sandstone into this rock in search of ore, has often been discussed and urged by them. In regard to these points, of so much economical importance to the lead-region, the Report has the following:*

"There is very little evidence that the crevices continue to be productive, in the Dubuque district, even as low down as the Blue limestone; and it is certain from the study of the whole region, that they are everywhere completely cut off by the Upper sandstone. In no instance, so far as we have been able to learn, have the lodes been found to extend more than a short distance into the sandstone, or to be productive of galena in that rock. It is true that, in some localities, ore has been found in the limestone underlying this sandstone (the Lower Magnesian), when this rock occupies the surface; but the deposits in that geological position are very few in number, and the ore limited in quantity; we have yet to learn of a single instance in which diggings in that rock have been profitable for any length of time. But, again, even if the Lower Magnesian were a good mineral-bearing rock, there would be little encouragement to continue sinking from the Galena limestone, through the sandstone, into the underlying sandstone; for there is no reason to suppose that a crevice, after being entirely interrupted in the sandstone, would be resumed in the limestone below, at a point exactly in the line of direction of the workings above. A miner would be no more justified in

* Report p. 462.

sinking through the sandstone, in the expectation of meeting a continuation of his crevice in the Lower Magnesian, than he would be in commencing a shaft anywhere at random in this rock, without regard to surface-indication, and expecting to strike a valuable lode. He might possibly find one; but the chances would be more than ten-thousand to one that he would not."

That the amount of lead produced in the Upper Mississippi region is gradually diminishing is evident from the statistics; the maximum produce of these mines was in the years 1845–47, when it was nearly 25,000 tons per annum. At present it amounts to less than half that. In answer to the question, what can be done to develop the mining interest of this region, a systematic topographical and mining survey of the whole lead-bearing region is urged as an indispensable preliminary to future successful explorations. A more or less symmetrical disposition of the crevices will be found to prevail, and from the symmetry of the known, the position of the unknown may possibly be ascertained. There is no doubt that heavy bodies of ore yet remain concealed under the thick covering of drift, which makes surface explorations so expensive, and that a large amount of labor is wasted in fruitless search for workable lodes which might be more profitably expended if more systematically directed.

The existence of zinc ore in sufficient quantity and under suitable conditions with reference to fuel, labor, and a market, is pronounced highly questionable. Gold is not to be looked for, except in the most minute quantity, a caution inserted with special reference to the gold-fever raging in Central Iowa, at the time this portion of the Report was passing through the press. Specimens of considerable size may, possibly, have found their way out of the pockets of returned California miners, into the soil of Iowa.

In closing the Report, we would express our earnest hope that the survey so well begun, may be continued to its completion, and that other volumes as valuable may soon follow.

ART. XVI.—*Correspondence of Prof. Jerome Nicklès, dated Paris, October 26th*, 1858.

Scientific Association at Carlsruhe.—We ask our readers this time to go beyond the bounds of France across the Rhine. We need make no apology for this, as science is of all countries, and the announcement of scientific news is our special duty as correspondent of the American Journal.

The German Scientific Associations are generally highly interesting, as much for the men that attend them as the subjects discussed. Few meetings however have been as important as this 34th, held at Carlsruhe,

the capital of the Grand Duchy of Baden. It was remarkable for the sympathy between the government and the people, and also for the men there gathered and the papers brought forward. The first of the chemists and physicists of Germany were there; and geology, mineralogy, botany, zoology, and medicine had equally distinguished representatives. As the meeting was divided into sections, we could not hear all, and selected those departments according with our own predilections,—physics and chemistry; and we therefore confine our communications to facts brought out in these two sections.

The presidents of the section of chemistry were successively Liebig, Wöhler, Schönbein, and on the declinature of Bunsen, H. Rose. The sessions began on the 17th of September.

Schlossberger on the property of ammoniacal oxyd of copper dissolving cellulose.—This property was made known some years since by Schweitzer. Not only cellulose but also silk is soluble in this reagent. The ammoniacal sulphate of copper acts as a solvent only from the excess of oxyd of copper present. Mr. Schlossberger finds that the solvent power increases with the proportion of copper, and that the hydrate of copper dissolved in ammonia acts better than the sulphate.

The cupro-ammoniacal liquid does not dissolve gum, dextrine, starch, while it does dissolve filtering paper. The salts, and especially the alkaline salts, precipitate this solution of cellulose, and sulphate of copper has the same effect. The precipitate shows no trace of organization or crystallization; and it does not appear to differ in percentage composition from that of cellulose.

These same alkaline salts do not precipitate the solution of silk, and the fact may be made the basis of a process for separating silk from cotton. The solution of cellulose is precipitated also by alcohol, a concentrated solution of honey, gum Arabic, or dextrine. The cupro-ammoniacal liquid has no action on pyroxyline or collodion. Inuline, chitine, conchyoline, are insoluble in it.

Mr. Schlossberger has found that the ammoniacal hydrate of nickel, $NiO\,H^3N$, acts like the salt of copper. The solution of silk is however a fine blue in the latter and a yellowish brown in the former.

J. Nicklès on the diffusion of fluorine and the means of detecting it.—In this paper, the subject of which has been briefly presented in this Journal before, the following conclusions were arrived at.

1. There is fluorine in the blood, but less than has been supposed.

2. There are only small traces of fluorine in bones. After Berzelius, the proportion is 3 grams in 100 grams of the calcareous part of bones; but we have shown that there is hardly 0·05 in a kilogram.

3. The sources from which the animal organization may derive fluorine are: (*a*) potable waters; (*b*) vegetable substances,—although some contain so little that it is necessary to experiment on a kilogram at least of ashes, and on the products of evaporation of some thousand litres of water. Besides, some mineral waters are a source containing fluorine in even a large proportion—a fact that may explain the efficiency of certain mineral waters that are feebly mineralized, such as those of Plombières, and Mont d'Or, etc.

4. The water of the Seine taken at Paris, is one of those containing the least fluorine.

5. Of the rivers of France, one of the richest in fluorine is that of the La Somme near Amiens.

6. Mineral waters vary in amount of fluorine; the richest examined are, the waters of Contrexeville, Antogast, Rippoldsau, Geilnau and Châtenois (Bas-Rhin). Reactions may be obtained from a litre of these waters.

7. The Atlantic affords no sensible amount even from 300 litres, showing thus a striking difference between marine and mineral waters.

8. The law of the diffusion of fluorine may be thus expressed: *There is fluorid of calcium in all waters containing bicarbonate of lime, and therefore there may be fluorine in all rocks and minerals formed in a sedimentary way.*

9. There are two sources of error in the usual method of detecting fluorine—one arising from the fact that sulphuric acid alone will attack glass, and the other from the fact that this acid often contains small quantities of fluohydric acid.

10. These sources of error are eliminated from my methods—by using (*a*) quartz crystals in place of glass, and (*b*) sulphuric acid free from fluohydric acid.

11. The solvent which I use is chlorhydric acid, which, with a little care, may be found free from fluorine in the shops.

In the memoir I point out the circumstances under which such a chlorhydric acid may be produced in the manufacture in the large way.

On the Preparation of Ozone by von Babo, and by Messrs. Bunsen and Magnus.—The apparatus in which ozone is obtained by the combustion of phosphorus, permits of separating the gas from the phosphorous acid with which it is ordinarily mixed. This result is attained by causing the gas to pass through a solution of chromic acid. This acid not only oxydizes the phosphorous acid, but, as Baumert has shown, it increases the quantity of ozone; for after the washing there is more ozone than before, evidently because the oxydation of phosphorous acid is itself a cause of ozonization.

Von Babo has succeeded in drying ozone so far as to render it anhydrous, whence it follows that ozone, or at least this kind of ozone, cannot be confounded with the hydrogenated ozone HO^3 discovered by Baumert.

Bunsen and Magnus, who made remarks on this paper, expressed the opinion that we must admit two kinds of ozone, one allotropic oxygen and the other a hydrogenated compound.

Schönbein on Ozone.—See page 19 of this volume.

Notices by Prof. Erdmann, of Leipzig.—The name of Erdmann is in high regard among chemists, as well from his fine researches, as from his being the early teacher of the lamented Gerhardt.* Erdmann had the insight to detect the future greatness of this distinguished chemist and to open the treasures of his science to his pupil—so early deceased—whose labors have so greatly enlarged the horizon of chemistry.

It was our good fortune to make the personal acquaintance of the first master of our lamented friend, and to obtain from him information on the

* See our biog. notice of Gerhardt, this Jour., Jan., 1857, p. 102.

obscure points of his youth and his early scientific career. From this source we derive our knowledge of several new facts first established in his laboratory.

(1.) *Blistering principle of Ranunculus sceleratus.*—This principle occurs under the form of an acrid oil, which on the tongue is changed into a white mass of *anemonine* and *anemonic acid.* This transformation occurs in the plant during desiccation, but the vegetable then loses all its bitterness.

(2.) *Action of certain Metallic Salts on ligneous fibres.*—It is well known that to preserve wood, and particularly the ties of railways, it is usual to impregnate them with a solution of sulphate of copper. This salt combines with the fibre in a manner so intimate as to preserve it from the action of water, which has no effect to dissolve out the copper salt even when the prepared wood is submerged. This change happens only to wood in its natural state, for if the fibre is purified from albuminous matters, &c., although the copper salt appears to combine perfectly with it, on the least action of water it is dissolved out. Dilute solutions of sulphate of copper, in fact, remove the azotized substances from wood.

(3.) *Solubility of Sulphate of Baryta.*—This salt, one of the most insoluble of all substances in water, is soluble in water containing nitrate of ammonia, a concentrated solution dissolving sulphate of baryta in considerable proportion.

On new hydrocarbons and a new property of these bodies; by Mr. Fritzsche, of St. Petersburgh.—These hydrocarbons have been discovered in the tar resulting from the distillation of wood. They possess the peculiarity of forming beautiful and well defined crystalline compounds with picric acid, as well as those known of naphthaline and benzine. As the researches of Fritzsche have been some time published, we refer the reader to his memoir.

Manufacture of Soda and Baryta; by Mr. Kuhlmann.—The new facts established by Mr. Kuhlmann, of Lille, owe their discovery to a desire to render salubrious the manufacture of carbonate of soda by the process of Leblanc, which has heretofore been predjudicial to the public health, owing to the vast volumes of chlorhydric acid gas which have pervaded the atmosphere near such establishments. Mr. Kuhlmann has succeeded in avoiding this nuisance by the following process: He conducts the acid gases over masses of native carbonate of baryta, which arrest the hydrochloric acid, forming chlorid of barium. This salt, by means of dilute sulphuric acid, is changed into sulphate of baryta, which is now in great demand in the arts under the name of *blanc fixe* (permanent white). He manufactures 2000 kilograms per day.

Another new fact established by Mr. Kuhlmann relates to the economy of the residues of chlorid of manganese, resulting from the production of chlorine and hypochlorites. These residues retain a large quantity of chlorine, and Mr. Kuhlmann, who is one of the principal manufacturers, estimates the loss from this source to be not less than two million francs in France alone.

This skilful chemist has contrived two uses for these residues. Either he transforms them into chlorid of barium by means of carbon and sul-

phate of baryta, or he treats them by another residue which encumbers the soda-industry, viz., the oxysulphid of calcium, by which sulphid of manganese and chlorid of calcium result. The latter salt is now beginning to be used to prevent combustion and to water streets in summer, where by its hygroscopic properties it keeps down the dust.

All these researches were brought up in the first two sessions of the chemical section; but the third session was united with that of the physical section. On the next day there was an excursion to Baden Baden, when the Congress was fêted by that city. The Monday session was commenced at 11 o'clock, and there were many interesting experiments exhibited. The chief were—

Dove's Experiment in Acoustics.—This experiment consists in rendering the tone from a vibrating diapason, very distinct, so that it could be heard through the whole hall, by causing it to vibrate in a certain relation to a glass flask containing water. The flask should not be filled and the diapason should not touch it, but be held by the hand in the prolonged neck of the balloon. The sound returned depends on the position of the two limbs of steel to the neck of the flask. The perception of sound is most distinct when the plane of the two branches is in the axis of the neck, and it is null when this plane is perpendicular to the axis.

Dove ascertained these facts while engaged in researches as to the question whether the ear, which is for a time sensible to a certain tone, becomes insensible to it again, as the eye does to a given color when it has for some time contemplated it. The eye may be said to habituate itself to certain colors, as the olfactory nerves do to persistent odors. Dove's researches returned an affirmative reply to the point in question.

Magnus on the properties of iron in powder.—Metallic iron in a state of very fine division has for some years been used in medical practice. It is thus obtained when the oxyd of iron is reduced by hydrogen. When well prepared this form of iron is so combustible as to take fire on exposure to air, burning with scintillation. A manufactory has lately been established in the Tyrol for making iron-powder, of very considerable fineness—although the process is mechanical, consisting in using very fine files. Its therapeutic properties have not yet been decided. It does not burn spontaneously in air although it is extremely combustible, as the following experiment by Magnus demonstrated to the section. When a burning body is approached to these Tyrolean filings they do not inflame unless they are previously suspended from the poles of a magnet. It is an experiment easily repeated and interesting in a lecture. If a magnet be thus armed with these fine filings, and a flame applied, a combustion begins which spreads rapidly, and if the magnet is jarred a shower of burning particles fall through the air.

Boettger—Action of cold and warm water on horny substances.—This skillful experimenter whose tact in manipulation is well known, having obtained the floor of the Section, took a goose feather, placed it between the thumb and fore-finger of one hand and with the other crushed it into a crumpled mass. He then by a little manipulation restored it completely to its primitive state. The treatment by which this was accomplished was simple enough. After being left for some minutes in warm

water it was plunged into cold water; this restored the rigidity of the feather previously swollen by the warm water.

Schroeder—Relation between fermentation and crystallization.—In 1854 Mr. Schroeder in connexion with Mr. Dusch published a paper on fermentation and putrefaction, and showed that putrescent and fermentable substances could be indefinitely preserved, if instead of leaving such matter in common air, they were placed in vases filled with air that had been filtered through cotton. Flesh, soup, and all kinds of alimentary substances can thus be preserved, if the precaution has been taken previously to boil them in water.

Mr. Schroeder shows that what he has established concerning fermentation and putrefaction, is also true of crystallization. It is well known that a saturated solution of sulphate of soda remains liquid as long as it is in vacuo, but solidifies on access of air. Mr. Schroeder establishes the fact that crystallization does not take place if the air is made to pass through a tube filled with cotton.*

Mr. S. explained the results of his experiments in 1854 by supposing that the air filtered through cotton is deprived of the spores of cryptogamic infusoria, which are the cause of putresence and fermentation. If the experiment on the sulphate of soda tends to establish a relation between fermentation and crystallization, it serves to prove also that these phenomena can take place without the presence af these cryptogamia or infusorial germs, suspended in unfiltered air. This question which appeared to us finished by the earlier researches of Mr. Schroeder, comes up anew. These facts do not interfere with the mechanical theory of Liebig, nor that derived from the recent researches of Pasteur on the propagation of fermentation.

J. Nickles—Electromagnets and Magnetic adhesion.—The experiments on this subject have been reported briefly in former communications. They have acquired a new interest since the French Government has ordered General Morin, of the Department of Arts and Trades, to take up that part of my researches which is applicable to locomotion on railroads.

Before my investigations, only two kinds of magnets were known, the *straight* and the *horseshoe* or *bifurcate*.† In 1852 I made known the *trifurcate* magnet, (or magnet with three poles having only a single helix for magnetization although possessing considerable attracting power,) and the *paracircular* magnets,‡ and afterwards the *circular*. § These last two kinds have some special properties, and are capable of transmitting motion as the revolution takes place, but the magnets which I call *circular* are polished at the circumference and without teeth. These magnets attracted much attention on account of their peculiarities and practical applications. One of them has been put in action on a large scale on the Lyons railroad.

This meeting of the German Association was without representatives from England, and but for the position of Carlsruhe would scarcely have had any from France. This is owing principally to the fact that Associations are in session in England, France, Italy and Germany at nearly the same

* Journal de Pharmacie and de Chemie, 1854, T. xxv, p. 314.

† This Journ., xv, 104, 380. ‡ Ibid, xvi, 110. § Ibid, xx, 99.

period of the year. The only way to remedy this difficulty is to substitute for these partial associations, a *European Scientific Association*, precursor to a *Universal Scientific Association*, which shall hold its sessions in turns at the different cities of the old and new continent.

Bibliography.—At H. Bossange's: *Researches on the Diffusion of Fluorine*, by J. Nicklès. 60 pp. 8vo.

SCIENTIFIC INTELLIGENCE.

I. CHEMISTRY AND PHYSICS.

1. *On the Siliciuret of Hydrogen.*—Wöhler has communicated a purely chemical method of preparing the siliciuret of hydrogen discovered by Buff and himself as a product of the electrolysis of an alloy of silicon and aluminum. The method in question was accidentally discovered in Wöhler's laboratory by Martins, who found that a scoria or slag arising from the preparation of magnesium by Deville's process, disengaged a spontaneously inflammable gas when treated with chlorhydric acid. The magnesium compound required in the preparation of the gas is prepared in the following manner: 40 grams of fused chlorid of magnesium, 35 grams of strongly dried fluosilicate of sodium, and 10 grams of fused chlorid of sodium are to be finely pulverized and intimately mixed in a hot mortar. The mixture is to be introduced into a glass vessel which can be closed, and 20 grams of sodium in very small pieces added. The whole is to be mixed by agitation, and then forced at once into a Hessian crucible, heated to redness. The crucible is to be covered and heated, when the combination takes place with repeated decrepitations. When these have ceased and flames of sodium no longer appear, the crucible is removed from the fire, allowed to cool, and broken. It contains a greyish-black fused mass filled with globules and plates resembling cast iron. The coarser pulverized mass is to be introduced into a flask with two tubulures, through one of which passes a funnel with a tube long enough to pass to the bottom of the flask, to the other tubulure is attached a short and wide conducting tube. The entire apparatus is now to be filled with boiled water, and then plunged beneath the surface of the pneumatic cistern, so that every bubble of air is expelled. A collecting tube may now be filled with water and inverted over the orifice of the tube conveying the gas. Strong chlorhydric acid is now to be poured through the funnel. A violent reaction ensues and much foam unavoidably passes over into the collecting tube with the gas; a second tube may, however, be filled with the gas without foam. The properties of the gas are as follows. Each bubble inflames on contact with air with a white flame and a violent explosion. The silicic acid formed produces beautiful rings like phosphuretted hydrogen. The gas is completely decomposed by a feeble red heat, brown amorphous silicon being deposited. When burned against a plate of porcelain it gives a brown spot. With chlorine the gas explodes violently, but not with protoxyd or deutoxyd of nitrogen. As thus prepared the gas still contains free hydrogen, which makes it difficult to determine its constitution. Siliciuret of hydrogen precipitates various metals from their solutions. A salt of copper agitated with the gas yields a red pellicle of a siliciuret of copper, which in the air oxyd-

izes to a lemon-yellow silicate of copper. Nitrate of silver yields with the gas a black substance which is doubtless a siliciuret of silver, mixed however with metallic silver: palladium is reduced by the gas to the metallic state. The greyish mass which yields the gas by the action of chlorhydric acid, appeared to consist of free silicon mixed with a siliciuret of magnesium which gives siliciuret of hydrogen by the action of chlorhydric acid, and of another siliciuret of magnesium which yields with chlorhydric acid free hydrogen and protoxyd of silicon. In one case the authors succeeded in isolating a lead-grey aggregate of regular octahedrons, sometimes presenting cubic surfaces. These were found to have the formula $Mg_2 Si$, and as this compound yielded the spontaneously inflammable gas with chlorhydric acid, it is possible that the formula of this latter may be SiH_2. Martins is engaged in studying the subject further.—*Ann. de Chemie et de Physique*, liv, 218, Oct. 1858.

[NOTE.—It must be remembered that Wöhler and Martius take the equivalent of silicon as 21, so that silica is SiO_3. The siliciuret of magnesium above mentioned has no probable formula if we take silicon as 14, as appears necessary, since Marignac has shown the isomorphism of the fluosilicates and fluostannates. It is very much to be desired that those chemists whose means enable them to make such researches, should investigate the compounds of silicon with ethyl, methyl, &c. It can hardly be doubted that ethyl-zinc would give with chlorid or fluorid of silicon, a compound of ethyl and silicon having the formula $Si(C_4H_5)_3$ since we should have a reaction expressible by the equation

$$2 . Zn(C_4H_5) + Si\,Cl_3 = 2Zn\,Cl + Si(C_4H_5)_3.$$

A determination of the density of the vapor of ethyl-silicon would possess much theoretical interest. The results obtained by Hoffmann and Cahours in the formation of compounds of ethyl, &c., with phosphorus and arsenic render the existence of similar compounds of silicon and boron almost certain.—W. G.]

2. *On protoxyd of iron with caustic potash as a reducing agent.*—HEMPEL finds that protoxyd of iron in the presence of an excess of caustic potash reduces iodic acid, bichlorid of platinum, and protochlorid of mercury. Platinum yields a black powder which after washing with water containing chlorhydric acid and drying, readily converts alcohol into acetic acid. A solution of chlorid of mercury treated with sulphate of iron and caustic soda, and then with sulphuric acid yields subchlorid of mercury and the filtrate is free from mercury. Nitrate and sulphate of protoxyd of mercury behave in this manner when a sufficient quantity of chlorid of sodium has been previously added. The author recommends this process for the determination of mercury, the precipitated calomel being collected on a weighed filter, washed and dried. To determine mercury volumetrically, Hempel gives the following process, which yields very good results. The solution of the chlorid, nitrate or sulphate of mercury (in the two last cases chlorid of sodium must be added,) is to be introduced into a capacious flask with a ground stopple, an excess of protosulphate of iron and caustic alkali added, the flask well shaken and the oxyd of iron dissolved by adding dilute sulphuric acid. The subchlorid of mercury is allowed to settle and the supernatant liquid filtered off. After complete washing the filter may be pierced and the contents washed down into the flask with the rest of the precipitate. A large excess of

dilute sulphuric acid and hypermanganate potash is then to be added, the flask closed and strongly shaken for two or three minutes. The undecomposed hypermanganate of potash is then to be removed by a solution of oxalic acid, and the excess of this last determined by means of a titred solution of the hypermanganate. The percentage of mercury is then easily calculated.—*Ann. der Chemie und Pharm.* cvii, 97.

3. *On the Iodid of Methylen.*—When powdered iodine is added to crystallized ethyloxyd-soda a strong reaction occurs, and the mass becomes fluid. By distilling the mass Buttlerow obtained a heavy oily substance dissolved in alcohol and precipitated from this by water: this is the iodid of methylen $C_2H_2I_2$. The same substance is formed in larger quantity when one eq. of iodoform C_2HI_3 is added to three eqs. of ethyloxyd-soda, and water added to the product of this reaction. The iodid is a heavy oily liquid of a yellowish color and of density 3·342: at 2° it solidifies to a crystalline mass. By heating the iodid with acetate of silver and a little crystallizable acetic acid to 100° extracting the mass with ether and then distilling, a colorless oily liquid passed over at about 170°. This is the acetate of methyl-glycol $\left.\begin{matrix}C_2H_2\\(C_4H_3O_2)_2\end{matrix}\right\}O_4$. The author did not however succeed in obtaining methyl-glycol from this body.—*Ann. der Chemie und Pharmacie*, cvii, 110.

4. *On the action of Ammonia upon Glyoxal.*—By the action of nitric acid upon alcohol Debus obtained two new bodies termed respectively glyoxal $C_4H_2O_4$ and glyoxylic acid $C_4H_4O_8$. By the action of a warm and concentrated solution of ammonia upon glyoxal, Debus obtained a base having the formula $C_{12}H_6N_4$, its formation being represented by the equation

$$3(C_4H_2O_4) + 4NH_3 = C_{12}H_6N_4 + 12HO.$$

Glycosin the new base is a light white powder soft like talc and without taste or smell: it sublimes without melting, and yields beautiful needles. With bichlorid of platinum it yields a beautiful yellow crystalline powder, which has the formula $C_{12}H_6N_4 + 2(HCl, PtCl_2)$ or $C_{12}H_8N_4Cl_2, 2PtCl_2$. The rational formula of glycosin according to Debus is

$$N_4\left\{\begin{matrix}C_4H_2\\C_4H_2\\C_4H_2\end{matrix}\right\}.$$

The mother-liquor from which the glycosin is obtained yields with oxalic acid the oxalate of a new base which the author terms glyoxalin, and which has the formula $C_6H_4N_2$. Glyoxalin is colorless and crystalline; its platinum salt has the formula $C_6H_4N_2$, $HCl + PtCl_2$ and crystallizes in magnificent orange-red prisms. The formation of glyoxalin is expressed by the equation

$$2(C_4H_2O_4) + 2NH_3 = C_6H_2N_2 + C_2H_2O_4 + 4HO.$$

Ann. der Chemie und Pharmacie, cvii, 199.

5. *On the constitution of Tantalite.*—H. Rose has published an elaborate discussion of the analyses of tantalite from different localities, and arrives at the conclusion that the formula of the unaltered mineral is $FeO, 2TaO_2$, a portion of the tantalic acid being replaced by stannic acid SnO_2 and zirconia, which latter has probably the formula ZrO_2, as Deville and Troost have suggested.—*Pogg. Ann.*, civ, 85.

6. *On Niobium.*—H. Rose has published in part, the results of his long continued and elaborate investigations of niobium and its compounds—investigations which may justly be considered as among the most difficult and tedious which chemists have ever undertaken. We shall content ourselves with a brief abstract of the most important points in the history of the metal.

Metallic niobium is most easily prepared by heating the double fluorids or hypofluorids of niobium and the alkaline metals with sodium to a strong red heat in a crucible of cast iron. After cooling, the black mass is to be diffused in cold water in a platinum capsule; the metallic niobium boiled with water, and finally washed with water containing a little alcohol, till the washings leave no residue on evaporation. The metal obtained is purer, when a tolerably thick layer of chlorid of potassium is placed upon the mixture of fluorids with sodium before ignition. Metallic niobium is a black powder which conducts electricity, and is acted on by reagents more easily than tantalum. Freshly prepared and still moist niobium when heated with dilute chlorhydric acid is dissolved with evolution of hydrogen. The colorless solution gave with ammonia a voluminous precipitate of a brownish color, which however oxydized upon the filter and became white. It is therefore clear that there exists a stage of oxydation of niobium which is lower than hyponiobic acid. Nitric acid does not dissolve niobium even on heating. Concentrated sulphuric acid dissolves metallic niobium by long heating, the solution has a brownish color and gives a brownish precipitate with ammonia. Fluohydric acid also dissolves niobium, and the solution is effected still more easily by a mixture of sulphuric and fluohydric acids. Fusion with carbonate of potash and boiling with caustic potash, also dissolve the metal. When heated in chlorine the metal ignites, both the yellow and the white chlorid being formed—the latter, Nb_2Cl_3, in large excess. This latter cannot be converted into the yellow chlorid $NbCl_2$ by heating in chlorine. The oxydation of niobium yields only hyponiobic acid Nb_2O_3, and not niobic acid NbO_2, so that in this respect the metal differs from tantalum. The density of the metal obtained from the fluorids was 6·297; of that obtained from the yellow chlorid by means of sodium, 6·272, but the density varied greatly in different specimens in consequence of the presence of more or less hyponiobic acid as impurity. When phosphorus vapor is passed over bi-hyponiobate of soda, heated to redness in a current of hydrogen, the metal is reduced and contains only a trace of phosphorus: this reduction takes place much less easily and completely in the case of tantalum. In his second memoir Rose treats of the chlorids of niobium. The yellow chlorid, $NbCl_2$, resembles the corresponding chlorid of tantalum, $TaCl_2$, but has a clearer and somewhat deeper color; it is also more volatile than the latter, beginning to pass over at 125° C., while chlorid of tantalum becomes gaseous at about 144° C. The chlorid of niobium melts at 212° C., and solidifies sooner than the chlorid of tantalum, which fuses at a rather higher temperature. Rose made repeated analyses of the chlorid of niobium, decomposing it with water, and determining the chlorine and niobic acid produced. These analyses from the extreme difficulty of the subject did not yield results which correspond as accurately as could be desired. The author rejects the results of the first five, and

from the mean of the last three deduces the numbers 48·82 (or 610·37 O = 100) as the equivalent of niobium.

Chlorid of niobium, $NbCl_2$, dissolves in chlorhydric acid; after some time the solution becomes turbid and gelatinizes. Water does not completely dissolve the mass, the filtrate is opalescent, and contains much niobic acid, which may however be almost completely separated by boiling. When, however, the chlorid is boiled with chlorhydric acid, a turbid solution is produced, which does not gelatinize, and forms with water a clear solution which is not precipitated by boiling. The chlorid dissolves in alcohol to form a clear solution, while a small quantity remains which gelatinizes with water. When the alcoholic solution is distilled, alcohol, chlorid of ethyl, and finally, chlorhydric acid pass over, while a syrupy liquid remains which dissolves in water, giving a clear solution from which nothing is precipitated by boiling. The syrupy liquid is doubtless niobate of ethyl. When chlorid of niobium is dissolved in chlorhydric acid, water added, and then metallic zinc placed in the solution, a beautiful blue color is produced. Bromine forms two compounds with niobium, one of which is yellowish and voluminous, and corresponds to the hypochlorid, while the other is purple-red, but becomes yellow on strong heating and volatilizes. The yellow color of the hypobromid and the red of the bromid appear to be due simply to the presence of free bromine.

In a third memoir the author treats of the fluorids of niobium. The hydrate of niobic acid dissolves readily in fluohydric acid, and the solution gives a series of crystallized double fluorids. The potassium salts are colorless and crystalline. Of these, one has the formula $KF + NbF_2$, while the other is $(KF + NbF_2) + (KF + HF)$. The soda salts are $NaF + NbF_2$, $(2NaF + NbF_2) + (NaF + HF)$, and $(NaF + NbF_2) + (NaF + HF)$. It is difficult however to obtain these salts in a state of purity.—*Pogg. Ann.*, civ, 310, 432, 581.

7. *On the constitution of titaniferous iron ores.*—RAMMELSBERG has published an elaborate investigation of the titaniferous iron ores, the principal results of which are as follows:

(1.) The greater number of the titaniferous iron ores, among them all the crystallized forms, consist of 1 eq. of titanic acid and 1 eq. of protoxyd of iron (prot. of manganese or magnesia).

(2.) Magnesia is an essential constituent of all these ores. In the crystallized mineral from Layton, the magnesia amounts to 14 per cent.

(3.) According to Mosander's theory the titaniferous iron ores are either simply titanates of protoxyd of iron $\dot{Fe}\ddot{Ti}$; with isomorphous admixtures of titanate of magnesia or mixtures of such with sesquioxyd of iron, for the most part in simple proportions.

(4.) The theory of H. Rose that these ores consist of isomorphous sesquioxyds of titanium and iron, would require the assumption of a sesquioxyd of magnesium.

(5.) The author prefers Mosander's theory for the present state of our knowledge.

(6.) In Iserin we find grains consisting of $\dot{Fe}\ddot{Ti}$, and $\dot{Fe}\ddot{Ti}_3$.

(7.) No titaniferous iron crystallizing in regular octahedrons is known. The dense masses or octahedral grains which contain titanium appear to be mixtures.

(8.) The crystallized magnetic iron ores contain no titanium, they consist of one atom of protoxyd and one atom of sesquioxyd.

(9.) All the Elba iron ore does not contain titanium, but all, like that from Vesuvius, contains magnesia and protoxyd of iron.

(10.) The strongly magnetic octahedrons from Vesuvius, hitherto considered as a specular iron, which are accompanied by rhombohedrons of specular iron, contain in part large quantities of magnesia, and in part protoxyd of iron. They consist either of magnetic iron which has been partially converted into sesquioxyd of iron, as well as of the isomorphous combination $\dot{\mathrm{M}}\mathrm{g}\overline{\mathrm{F}}\mathrm{e}$, or, as is more probable, the two protoxyds are isomorphous with sesquioxyd of iron, which is itself dimorphous.—*Pogg. Ann.*, civ, 497.

8. *On a new acid obtained by the oxydation of malic acid.*—By the action of bichromate of potash upon a dilute solution of malic acid, Dessaignes has obtained an acid which has the formula $C_6H_4O_8$, and which may possibly be identical with the nicotic acid of Barral. The author terms it provisionally malonic acid, and remarks that it is probably homologous with oxalic acid, being the term hitherto wanting between oxalic and succinic acids. Malonic acid forms large rhombohedral crystals, and is easily soluble in water and alcohol. It has a strongly acid taste, melts at 140°, and is decomposed at 150°. By dry distillation it yields a mixture of acetic acid with unchanged malonic acid; carbonic acid is set free at the same time, the equation being

$$C_6H_4O_8 = C_4H_4O_4 + C_2O_4.$$

Malonic acid forms neutral and acid salts with the alkalies. Malonate of ammonia precipitates the salts of lime, baryta, silver and mercury. The author remarks that while the analogy between malonic and oxalic acids is strongly marked, the resemblance between malonic and succinic acids is much less distinct.—*Comptes Rendus*, xlvii, 76. W. G.

9. *Remarks on Chemical Science;* by Sir JOHN HERSCHEL, at the recent meeting of the British Association at Leeds.—Since organic chemistry has assumed, by the experiments and reasonings of Dumas, Liebig, Hoffmann, and its other distinguished cultivators, that highly abstract and intellectual form under which it now presents itself, and which by the links of the platinum bases, and compounds such as those described by Gibbs and Genth, under the name of the ammonio-cobaltic bases, and by those which are every day coming into view by the mutual interweaving if I may use such an expression, of the organic and inorganic systems of composition in bases such as those of the metallic ethyls and those of boron and silicon, it seems to place these conceptions in much the same sort of relation to the ordinary atomic theory as put forth by Dalton and Higgins, and the elementary notions of oxyd, acid, and base of Lavoisier, that the transcendental analysis holds to common algebra. And here perhaps I may be tolerated if I put in a word of reclamation against the system of notation into which chemists who for the most part are not algebraists, have fallen, in expressing their atomic formulas. These formulas have been gradually taking on a character more and more repulsive to the algebraical eye. There is a principle which I think ought to be borne in mind in framing the conventional notations, as well as nomenclatures of every science, at every new step in its progress, viz: that as sciences do

not stand alone, but exist in mutual relation to each other—as it is for their common interest that there should exist among them a system of free communication on their frontier points—the language they use and the signs they employ should be framed in such a way as at least not to contradict each other. As the atomic formulas used by the chemist are not merely symbolic of the mode in which atoms are grouped, but are intended also to express numerical relations, indicative of the aggregate weights of the several atoms in each group and the several groups in each compound, it is distressing to the algebraist to find that he cannot interpret a chemical formula (I mean in its numerical application) according to the received rules of arithmetical computation. In a paper which I published a long time ago on the hyposulphites, I was particularly careful to use a mode of notation which, while perfectly clear in its chemical sense, and fully expressing the relation of the groupings I allude to, accommodated itself at the same time perfectly well to numerical computation, no symbol being in any case juxtaposed, or in any way intercombined with one another, so as to violate the strict algebraic meaning of the formula. This system seemed for a while likely to be generally adopted, but it has been more and more departed from, and I think with a manifest corresponding departure from intelligibility.

The time is perhaps not so very distant when from a knowledge of the family to which a chemical element belongs, and its order in that family, we may be able to predict with confidence the system of groups into which it is capable of entering, and the part it will play in the combination. A great step in this direction seems to me to have been lately made by Prof. Cooke of Harvard University, in the United States, (in a memoir which forms part of the 5th volume of the Memoirs of the American Academy of Arts and Sciences,) to extend and carry out the classification of chemical elements into families of the kind I allude to, in a system of grouping, in which the first idea, or rather the first germ of the idea, may be traced to a remark made by M. Dumas, in one of his reports to this Association, and which is founded on the principle of arranging them in a series, in each of which the atomic weight of the elements it comprises are found among the terms of the arithmetical progression, the common difference of which in the several series are 3, 4, 5, 6, 8, and 9 times the atomic weight of hydrogen respectively. So arranged they form six groups, which are fairly entitled to be considered natural families, each group having common properties in the highest degree characteristic; and what is more remarkable, the initial member in each group possessing in every case the characteristic property of the group in its most eminent degree, while the others exhibit that property in a less and less degree, according to their rank in the progression, or according to the increased numerical value of the atomic equivalent. Generally speaking, I am a little slow to give full credence to numerical generalizations of this sort, because we are apt to find their authors either taking some liberties with the numbers themselves, or demanding a wider margin of error in the application of their principles than the precision of the experimental data renders it possible to accord, so that the result is more or less wanting in that close appliance to nature which makes all the difference between a loose analogy and a physical law; but in this instance it certainly does

appear that the groups so arising not only do correspond remarkably well in their theoretical numbers with those which the best authorities assign to their elements, but that it really would be difficult to distinguish the elements themselves into more distinctly characteristic classes, by a consideration of their qualities alone, without reference to their atomic numbers. When we find, for instance, that the principle affords us such family groups as oxygen, fluorine, chlorine, bromine, and iodine, self-arranged in that very order; or again, nitrogen, phosphorus, arsenic, antimony, and bismuth; when we find that it packs together in one group all the more active and soluble electro-positive elements, hydrogen, lithium, sodium, and potassium, and in another the more inert and less soluble ones—calcium, strontium, barium, and lead—and that without outraging any other system of relations, it certainly does seem that we have here something much like a valid generalization: and I shall be very glad to learn in the course of any discussions which may arise on such matters as may be brought before us in the regular conduct of our business from those more competent to judge than myself, whether I have been forming an overweening estimate of the value and importance of such generalizations.

I will only add on this point, in reference to what fell from our excellent President in his address to the assembled Association last night, that this kind of speculation followed out would seem to me likely to terminate in a point very far from that which would regard all the members of each of these family groups as allotropes of one fundamental one, inasmuch as the common difference of the several progressions which their atomic weights go to make up, are neither equal to nor in all cases commensurate with the first terms of these progressions. For instance, in the chlorine group, the first term being 8, the common difference is 9. Something very different from allotropism is surely suggested by such a relation. It would rather seem to point to a dilution of energy of one primary element by the superaddition of dose after dose of some other modifying element, and this the more strikingly since we find oxygen standing at the head of very distinct groups having very striking correspondence in some respects, and very striking differences in others. But all these speculations take for granted a principle, with which I must confess I think chemists have allowed themselves to be far too easily satisfied, viz: that all the atomic numbers are multiples of that of hydrogen. Not until these numbers are determined with a precision approaching that of the elements of the planetary orbits, a precision which can leave no possible question of a tenth or a hundredth of a per cent, and in the presence of which such errors as are at present regarded as tolerable in the atomic numbers of even the best determined elements shall be considered utterly inadmissible, I think can this question be settled—and when such gigantic consequences—so entire a system of nature is to be based on a principle—nothing short of such evidence ought, I think, to be held conclusive, however seductive the theory may appear. I do not think such precision unattainable, and I think I perceive a way in which it might be attained, but one that would involve an expenditure of time, labor, and money, such as no private individual could bestow upon it. If the phenomena of chemistry are ever destined to be reduced under the

dominion of mathematical analysis, it will no doubt be by a very circuitous and intricate route, and in which at present we see no glimpse of light. We should therefore be all the more carefully on the watch in making the most of those classes of facts which seem to place us, not indeed within view of daylight, but at what seems an opening that may possibly lead to it.

Such are those in which the agency of light is concerned in modifying or subverting the ordinary affinities of material elements, those to which the name of actino-chemistry has been affixed. Hitherto the more attractive applications of photography have had too much the effect of distracting the attention from the purely chemical questions which it raises, but the more we consider them in the abstract, the more strongly they force themselves on our notice, and I look forward to their occupying a much larger space in the domain of chemical inquiry than is the case at present. That light consists in the undulations of an etherial medium, or at all events agrees better in the characters of its phenomena with such undulations, than with any other kind of motion which it has been possible to imagine, is a proposition on which I suppose the minds of physicists are pretty well made up. The recent researches of Professor Thomson and Mr. Joule moreover have gone a great way towards bringing into vogue, if not yet fully unto acceptation, the doctrine of a more or less analogous conception of heat. When we consider now the marked influence which the different calorific states of bodies have on their affinities—the change of crystalline form effected in some by a changing temperature—the allotropic states taken on by some on exposure to heat—or the heat given out by others on their restoration from the allotropic to the ordinary form (for, though I am aware that Mr. Gore considers his electro-deposited antimony to be a compound, I cannot help fancying that at all events the state in which the the antimony exists in it is an allotropic one); when, I say, we consider these facts in which heat is concerned, and compare them with the facts of photography, and with the ozonization of oxygen by the chemical rays or the electric spark, and with the striking attractions in the chemical habitudes of bodies pointed out by Draper, Hunt, and Becquerel; and when again we find these carried so far that, as in the experiments of Bunsen and Roscoe, we find the amount of chemical action numerically measuring the quantity of light absorbed, it seems hardly possible not to indulge a hope that the pursuit of these strange phenomena may by degrees conduct us to a mechanical theory of chemical action itself. Even should this hope remain unrealized, the field itself is too wide to remain unexplored; and, to say nothing of discovery, the use of photography merely as a chemical test may prove very valuable, as I have myself quite recently experienced, in the evidence it has afforded me of the presence in certain solutions of a peculiar metal having many of the characters of arsenic, but differing from it in others, and strikingly contrasted with it in its powerful photographic qualities, which are of singular intensity, surpassing iodine, and almost equalling bromine.

There is another class of phenomena which, though usually considered as belonging peculiarly to the domain of general physics, and so out of our department, seems to me to want some attention in a chem-

ical point of view. It is that of capillary attraction. The co-efficient of capillarity differs very remarkably in different liquids, and no doubt also in their contacts with different solids, a fact which can hardly be separated from the idea of some community of nature between the capillary force and those of elective attraction. I hardly dare to hint at the existence of some slight misgiving I have always felt as to the validity of the received statical theory of capillary action which carries with it the authority of such names as those of Laplace and Poisson. Any discussion of this point would be matter for another section of this Association, and if I here touch upon it, it is only to observe my impression of the requisiteness of a force so far allied to chemical affinity as to be capable of saturation, rests on other grounds besides that of the mere diversity of action above alluded to. But I must remember that you are not met here to listen to generalities of whatever nature, but that we have plenty of real and special business before us.

10. *An account of some experiments on Radiant Heat, involving an extension of Prévost's Theory of Exchanges;* by Mr. B. STEWART, (Proc. Brit. Assoc., Ath. 1614).—These experiments were performed with the aid of the thermomultiplier, the source of heat being for the most part bodies heated to 212°. Four groups of experiments were considered. Group the first contains those experiments in which the quantities of heat radiated from polished plates of different substances at a given temperature, are compared with the quantity radiated from a similar surface of lampblack at the same temperature. The result of this group of experiments is, that glass, alum and selenite, radiate about 98 per cent of what lampblack does—thick mica, 92—thin mica, 81—and rock salt only 15 per cent. The second group of experiments was designed to compare together the quantities of heat radiated at the same temperature from polished plates of the same substance, but of different thicknesses. The result of this group was, that while the difference between the radiating power of thick and thin glass is so small as not to be capable of being directly observed, there is a perceptible difference between the radiation from thick and thin mica, and a still more marked difference between the radiation from plates of rock salt of unequal thickness. The third group of experiments was made with the view of comparing the radiations from various polished plates with that from lampblack, as regards the quality of the heat,—its quality being tested by its capability of transmission through a screen of the same material as the radiating plate. From this group of experiments it appears that heat emitted by glass, mica, or rock salt is less transmissible through a screen of the same material as the heated plate than heat from lampblack,—this difference being very marked in the case of rock salt, which only transmits about one third of the rays from heated rock salt. The common opinion that rock salt is equally diathermanous for all descriptions of heat is therefore untenable. The fourth group of experiments shows that heat from thick plates of glass, mica, or rock salt is more easily transmitted by screens of the same nature as the heated plate than heat from thin plates of these materials. It was shown that all these experiments may be explained by Prévost's theory of exchanges, somewhat extended. This extension consists of the following laws:—1. Each particle of a substance has an independent

radiation of its own equal in all directions and without regard to the distance of the particle from the surface of the body. 2. The radiation of a particle equals its absorption, and that for every description of heat. 3. The flow of heat from within upon the interior surface of a polished plate of indefinite thickness is proportional to the index of refraction of the body, and that for every description of heat.

The bearing of these experiments on Dulong and Petit's law of radiation was then attempted to be traced. It was shown that unless bodies from simply being heated change their transmissibility for the same description of heat (which there is no reason to suppose), the radiation of thin plates or particles at a high temperature will bear a less proportion to the total radiation of that temperature than at a low,—the consequence will be, that the radiation of single particles will increase with the temperature in a less degree than Dulong and Petit's law would indicate. It may even be that the radiation of a particle or very thin plate may be proportional to the absolute temperature of that particle. Taking a piece of glass or mica, therefore, at a low temperature, as it is very opaque with regard to the heat radiated by itself, we may suppose that the total radiation consists of that of the outer layer of particles only, that from the inner layers being all stopped by the outer. At high temperatures, however, we may suppose that there is not only the radiation of the outer layer, but also part of that of the inner layer which has been able to pass, swelling up the total radiation to what it appears in Dulong and Petit's experiments. This way of looking at radiation may possibly bring the radiative power of particles to obey the same laws with the conducting power of particles, which Prof. Forbes has shown decreases with an increase of temperature. The author of this communication is indebted to Prof. Forbes for the use of the instruments and substances employed, and also for many valuable suggestions with regard to the experiments it contains.

11. *On the Phosphorescent Appearance of Electrical Discharges in a Vacuum made in Flint and Potash Glass;* by Mr. J. P. Gassiot, (Proc. Brit. Assoc. Ath., 1615).—The discharge from an induction coil when taken in a vacuum tube made of flint glass, has (under certain conditions) the property of rendering the glass highly phosphorescent, the phosphorescence being denoted by the intense blue color of the glass with which the stratifications are surrounded. On trying the discharge in some vacuum tubes I had obtained from Mr. Geissler, of Bonn, I observed that the phosphorescence was no longer blue, but was of a slight green color. To test whether this difference was due to the gaseous matter remaining in Geissler's tubes, or to the character of the glass which he uses, I had Torricellian vacuums prepared in German glass tubes, and in this manner ascertained that the difference in the color was entirely due to the character of the glass: that of Germany is, I believe, made with potash, and is entirely free from any lead, while in the English flint glass lead is introduced to some extent. I have recently obtained a vacuum tube from Bonn, which shows this difference in a very beautiful manner: the outer ends of the tube are composed of German glass, the centre of the tube is of English glass; by this arrangement the contrast between the two is very manifest.

12. *On Induced Electric Discharges when taken in Aqueous Vapor;* by Mr. J. P. Gassiot, (Proc. Brit. Assoc. Ath., 1615).—If the tube of a well constructed water-hammer is partly covered with two separate coatings of tin-foil, and the coatings are connected one with the outer, and the other with the inner terminal of an induction coil, a discharge will be observable through the centre of the tube in the form of a wave line. On repeating this experiment I ascertained that the vacuum in the tube was very much deteriorated. I could no longer produce that peculiar bubbling in the ball of the apparatus which is always attainable by gently heating the tube with the warmth of the hand; this bubbling was originally very sensibly perceptible in the tube I now exhibit when I first received it from the maker, Mr. Casella. I have repeated the experiment with other water-hammers, and always with the same result; but I have not yet opened one to examine whether the vapor has been decomposed, and gas evolved.

II. GEOLOGY.

1. *On Marcou's "Geology of North America;"* by Prof. Agassiz.—I have not yet seen Marcou's latest publication on American Geology, but I have now open before me, his paper in the Proceedings of the Geological Society of France, and that in Petermann's "Geographische Mittheilungen," both bearing date 1855, as well as the Geological Map of the United States and British North America by H. D. Rogers, also bearing date 1855, and Hall's and Leslie's Map of the country west of the Mississippi river, published with the 1st vol. of Emory's Report in 1857. I take it that it will be no injustice to either Rogers or Hall to go to an earlier publication of Marcou's, in a comparison of their respective claims to correct illustration of our Western Geology. Let me premise by saying that as far as the geology of the East is concerned, from Iowa to the Atlantic coast, I acknowledge that to Hall is due, unquestionably, the credit of having settled by extensive comparisons, and by personal examinations, the true geological horizon of the vastest extent of our continent, not only by an examination of the superposition of the rocks, but also by the most minute and most extensive study of the fossils.

We all know also how much the Rogerses have done to elucidate the physical geography, the orography, and the order of succession of the formations of Pennsylvania and Virginia, which has thrown much light upon the general geology of the eastern part of the continent. It is equally well known how much the special state surveys have added to the details in this general investigation of the Geology of North America. But when we go west of the Mississippi valley to the Pacific shores the case is very different. The maps of Rogers, Hall and Marcou, are a compilation and an attempt at coordination of surveys which cover only a very small portion of the ground. They are, as it were, the reading of the authors of these different maps, of investigations made by others, though Marcou has here unquestionably the advantage of having gone himself over the ground.

A comparison for instance, of the manner in which the volcanic rocks are dotted over New Mexico, Sonora, and Lower California, as well as in California, Oregon and Washington Territories by Hall and Rogers,

with Marcou's representation of the same cannot fail to show to a geological reader, that they are more natural in Marcou's map than in the two others. When a region is not more minutely surveyed than the whole western half of our continent, of which we have not even accurate geographical maps, it is not possible to expect accuracy in detail, and the critic must consider the general connection rather than special points.

I do not see, for instance, how the omission of State boundary lines which, in a former review of Marcou's map in the Journal, was made a prominent objection to his representation of American geology, can be of any importance in such a general survey of the subject. Rogers in his map does not give these boundaries any more than Marcou.

But I now come to the essential point. What is the true geological character of those five hundred thousand square miles of land, extending between the Mississippi, west of Arkansas and Missouri, and the great Salt Lake Basin? Rogers colors it uniformly with Cretaceous rocks, and the well known Tertiary deposits, adding metamorphic rocks, flanked with Carboniferous in the mountainous tracts. Hall does the same only making in addition, a distinction between the upper and lower Cretaceous, while Marcou distinguishes further between Permian, Triassic and Oolitic beds. I do not suppose that he, any more than Hall and Rogers, imagines that the boundaries he assigns to any of these groups are any more accurate than those assigned by Rogers and Hall to the groups they distinguish. These appear to me simply in the light of the respective readings of isolated facts recorded in the way they have struck the authors of these different maps. When in his paper to the Geological Society of France, Marcou speaks of himself as a travelling geologist who "brings his little stone to the great edifice" (page 3) it does not appear to me as vain-glorious boasting, and we ought to take gratefully the contributions of a Frenchman, using language after the fashion of his nation, even though it be not the way in which we would have expressed ourselves. Now I confess that after reading the condensed Review of American Geology which Marcou has given, in Petermann's Contributions, I find in it a more comprehensive account of the general features of the orography and geology of the Western half of our continent, than in the other representations I have read upon this subject. I think that even now a translation of that paper would be welcome to every English student of American geology, and that far from circulating false impressions, it would greatly contribute to bring before the mind the grand features of that remarkable country, and to connect in an intelligible way the geology of the West with that of the East. The middle tract of our continent is unquestionably occupied by deposits younger than the coal; I do not allude to the Lake Superior Sandstone respecting which I believe Marcou to be mistaken,—but the five hundred thousand square miles of questionable character as to the details, certainly belong to those from recent formations.

Now it appears to me that the geology of our Atlantic States furnishes data upon which theoretical inferences, bearing upon the question which Marcou's assertions call forth, may be founded. We know that the Cretaceous formations extend from the Atlantic slope of the Alleghany range round their southern spur into the great geological gulf

now occupied by the Mississippi valley. We know further that along the eastern slope of the Alleghanies, beginning with the Connecticut valley, there extends, between the axis of elevation of that chain and the Cretaceous deposits at its Atlantic foot, a series of deposits referred respectively to the Triassic and the Oolitic series.

We know also that to the south of North Carolina, these lower secondary deposits are covered over by the Cretaceous. Now, since the upheaval of the Alleghanies is anterior to the deposition of the Trias, does it not appear natural to suppose that Triassic and Oolitic formations must have been deposited at the foot of the western slope of the Alleghanies as well as upon its eastern slope, and that the Cretaceous deposits overlap them in the Mississippi gulf in various ways, as along the Allegbany chain, and that, following various routes, the different geologists who have gone across the continent must have seen, here Trias, then Jura, and then again Cretaceous beds, overlaid by Tertiaries, in a number of points, already determined, though the relative extent of all these beds, over a surface of 500,000 square miles, remains yet to be ascertained.

The circumstance that Marcou has colored in yellow the whole middle tract of the continent, can express nothing but his conviction that the whole Mississippi gulf is lined with Triassic beds, overlaid with more or less extensive Jurassic, Cretaceous and Tertiary deposits. In such a theoretic representation of the geological features, where the details are wanting, provided the existence of the Trias and Jura is made out somewhere, there is no more inaccuracy than in coloring a map of our eastern geology, where the drift covers the greatest extent of the surface, as if it were altogether occupied by Palæozoic rocks.

I take it that such things are, by this time, understood by all those who examine schematic maps,—at least they should be. Moreover, the discoveries by Professor Swallow and Mr. Meek of Permian beds in Kansas, along the eastern border of the great Mississippi gulf, and by Professor Hall in Iowa, furnish a very unexpected confirmation of the broad statement first made by Marcou, that while the Eastern part of our continent consists of Palæozoic rocks, the middle part is occupied by the Mesozoic series. I truly believe that, at some future period, the general outline of our western geology by Marcou, which by the way, has the priority over the others, will stand before a complete survey of the whole in the same light as Maclure's old map now stands, when compared to the well-known eastern geology.

In this connection, I cannot but remember that, with Thurmann, Mandelslohe, Gressly, Quenstedt, Römer, d'Orbigny and Oppel, Marcou is one of the geologists who knows the Jurassic formation best; that he has published a masterly paper upon the Jura Salinois in the Transactions of the Geological Society of France; and that it seems hardly credible to me that he should have been so completely mistaken in his identification of Oolitic beds in the west. I have myself, in my collection, a large number of specimens of the Cretaceous fossils of Texas and of New Jersey, among which is a beautiful series of the Exogyra, characteristic of the Cretaceous period, and I have seen the Exogyra and the Ostrea which Marcou brought from his excursion across the continent, and I distinctly remember that I could not identify them with the Cretaceous species, but rather thought them allied to Jurassic species.

Whoever has read Marcou's paper on the Jura must have seen that he knows, as well as any geologist living, that lithological characters are of no value in identifying geological horizons. But after having presented the general evidence, as far as it goes, for the presence of Triassic and Oolitic beds in the middle tract of our continent, I cannot find that there is any reason for blame, with his familiarity with the Triassic and Oolitic rocks of Europe, in his pointing out the lithological resemblance there may be between them, any more than there is ground for blaming the American geologists who, after identifying certain beds in New Jersey as Cretaceous, have also alluded to their mineralogical resemblance with the Green Sand of Europe; for this is, after all, a remarkable fact which runs over immense tracts of geological deposits belonging to the same horizon.

Reply to Prof. Agassiz on Marcou's Geology of North America, by James D. Dana.—I regret in such a case as this to have to differ from Professor Agassiz. The amount of difference is however not as great as at the first reading may appear; for an important part of the positions in my paper are untouched, and an explicit dissent from some of the views of Mr. Marcou is expressed.

The statements in Professor Agassiz's remarks to be especially noted are the following:

1. That Professor Agassiz had not read the work reviewed, but had seen the earlier papers by Mr. Marcou and examined his geological map.

2. That while, as regards the geology of the East from Iowa to the Atlantic coast, "to Mr. Hall is due unquestionably the credit of having settled by extensive comparisons and by personal examinations the true geological horizon of the vastest extent of our continent, not only by examination of the superposition of the rocks, but also by the most minute and most extensive study of the fossils;" and that while the "Professors Rogers have done much to elucidate the physical geography, the orography, and the order of succession of the formations of Pennsylvania and Virginia, and have thrown much light upon the general geology of the eastern part of the Continent,"—west of the meridian of Iowa their observations have not extended, and Marcou has thence the advantage of them.

3. That the maps of the region west of the Mississippi by Rogers, Hall, and Marcou are mainly compilations from the results of various surveys, and that Marcou in extending the colors of the Triassic formation over the 500,000 square miles of the Rocky mountains, and laying down also the Permian and Jurassic over the same region, was no more culpable than Hall or Rogers in covering it with Cretaceous.

4. That Marcou is mistaken in regarding the Lake Superior Sandstone as Triassic.

5. That it is hardly credible that Mr. Marcou should have been so completely mistaken in his identification of Oolitic beds in the west; and that the two species collected by Marcou from the beds are most allied, in Professor Agassiz's opinion, to Jurassic species.

6. That Mr. Marcou knows that lithological characters are of no value in identifying geological horizons; and that adding these characters to other general evidence for the Triassic and Oolitic rocks is not blameable.

The claims which Mr. Marcou has put forward in his work are: (1) the correct determination of the Red Sandstone of the Lake Superior region;

(2) the identification, for the first time, of the Permian over the Rocky Mountain region; (3) the same, of the Triassic; (4) the same, of the Jurassic. I have presented evidence proving, as I believe, that he was wrong in each case; and hence, that the claims of prediscovery which he is now urging over Europe are groundless. Besides this, I have pronounced the work abusive of such men as the Rogerses, Hall, Whitney, Logan, Hunt, and many others, and grossly unjust to American science and geological history, while full also of groundless personal claims. I review some of these points.

Supposed Triassic of Lake Superior.—Prof. Agassiz admits that he believes Mr. Marcou to be wrong with respect to the Triassic ("New Red") character of the Lake Superior Sandstone, and thus we do not differ as to this one of the claims.

Now this question of the Lake Superior Sandstone is the one that especially calls out Mr. Marcou's opinions of American geologists. Making these rocks, and the Connecticut river and Virginia beds, as well as 500,000 square miles of territory over the Rocky Mountains, "New Red," he is indignant that Hall, Whitney, Logan, Prof. Rogers, etc., do not follow in his track. After giving a one-sided view of opinions on the different rocks which he classes together as *undoubted* "New Red" he says:

> "It is difficult to present an age of strata in a manner more ambiguous and *empatée. The brothers Rogers and James Hall try their best to suppress* the New Red Sandstone formation in North America; but they do not know exactly what to do with these five or six thousand feet of strata. On the Geological Map of H. D. Rogers, the New Red Sandstone is unknown in the Magdalen Islands; on the north-east of the Baie des Chaleurs it is colored as Jurassic Red Sandstone, though the *Honorable Sir William E. Logan, Chevalier of the Legion of Honor,* calls it Carboniferous Sandstone. In Prince Edward Island, Connecticut valley, New Jersey, Pennsylvania, Maryland, Virginia and North Carolina, the New Red is colored as older Mesozoic (Jurassic coal and Jurassic red sandstone). In Lake Superior it grows older, and the New Red is colored Cambrian, (Primal, Auroral and Matinal). In the Praries, Texas, Rocky Mountains, New Mexico, etc., the "New Red," that seems to change its age with Protean facility, has once more renewed its youth and is colored as Cretaceous, and sometimes also as umbral and vespertine, or in ordinary language as Lower Carboniferous.
>
> "*They have not thought of putting the New Red in the Upper Silurian or the Tertiary. I would advise these honorable savants to consider if one of these determinations would not be preferable.*"

The *jumble* here is of Mr. Marcou's making, and it comes of his own errors about the "New Red." We let the style of criticism go without remark, satisfied for the present with italicizing only some of the more characteristic parts.

While on this topic, Mr. Marcou, noticing that Dr. D. D. Owen had within a few years taken the same ground with Prof. Hall and other geologists, says, "why Owen changed his views is quite a mystery." He will now regard the case of Dr. Owen not the only mystery.

Permian of the Rocky Mountain Region.—I pointed out in my review that Mr. Marcou had distinguished as Permian, rocks that contained fossils which he set down in his *Field notes* and *Resumé* with a query as a *Belemnite* and a *Pteroceras* (the latter word changed in the recent work to *Gasteropod*), although no Belemnite or Pteroceras is known to occur below the lower Jurassic (Lias). Disregarding or defying the hints from the imperfect fossils, he made the beds Permian on *lithological characters* and superposition alone.

On the Permian of Mr. Marcou, Professor Agassiz says nothing. The use made of lithological characters in its determination is far from sustaining the opinion cited above in paragraph 6.

Triassic of the Rocky Mountains.—My review states that Mr. Marcou established the existence of the Triassic on one fossil, and that an uncertain species of pine wood: this one doubtful fossil wood, and the *lithological characters* make up the evidence in favor of the discovery: and on *lithological characters* and superposition alone he based his queried subdivision of it, into *Bunter*, *Muschelkalk*, and *Keuper*—thus again badly misusing lithological evidence. He mentions also the discovery of a *Cardinia*, but says that Cardiniæ occur in rocks from the Jurassic to the Carboniferous.

Professor Agassiz brings forward nothing against my conclusion that the Triassic was not identified in the Rocky Mountains by Mr. Marcou.

Jurassic rocks in the Rocky Mountains.—The evidence which I cited that Mr. Marcou's Jurassic is really Cretaceous, was based on the determination by Hall, Conrad, Shumard, and others, that his supposed Jurassic fossils are Cretaceous, and that they occur at localities in the west along with known Cretaceous species. Morton's figure of the *Gryphea Pitcheri* (Morton) I understand was made by Conrad, so that Conrad is certainly good authority as to the identity between it and Mr. Marcou's species. Dr. Newberry, who has recently returned from the Rocky Mountains confirms these conclusions; for he says (see this volume page 33):

"I may say in confirmation of the assertion that your fossil plants [species of Alder, Beach, Credneria, Ettingshausinia, &c.] are Cretaceous, that I found near the base of the yellow sandstone series in New Mexico, considered Jurassic by Mr. Marcou,—a very similar flora to that represented by your specimens, one species at least being identical with yours, associated with *Gryphæa*, *Inoceramus*, and *Ammonites* of lower Cretaceous species."

With such evidence, even the exact identification of the two fossil shells is of little importance. The Cretaceous is the lowest formation in which leaves of any dicotyledons have been found.

Professor Agassiz states that Mr. Marcou is a good Jurassic geologist. But this does not affect the case in hand. For he had but two or three fossils about which to use his Jurassic judgment; and if this judgment has pronounced fossils to be Jurassic that really occur in the west associated with Cretaceous species, or if his knowledge of rocks in Europe has led him to think he can tell Permian, Triassic, or Jurassic rocks by their lithological characters, when he sees them in America, it has served him badly.

We regard it therefore as still true that Mr. Marcou's Triassic of Lake Superior, is not Triassic; and in the Rocky Mountain region, his Permian is not proved to be Permian, his Triassic not Triassic, and his Jurassic not Jurassic. Where are then his discoveries?

Map.—As regards the geological map-making, there is little resemblance between the cases of Rogers and Hall and Mr. Marcou. The former do not claim to be discoverers over the Rocky Mountain region, and Mr. Marcou does. Mr. Marcou, while remarking that the colors to the north and south of the course he followed are only approximative, says, "*I am sure of the limits of the formations on the line I have explored near the 35th parallel of latitude;*" and guided by this *sure* determina-

tion, he marked the Triassic on his map, and then, at a hazard, influenced by his views of earlier explorations, he spread the Triassic color far north over the 500,000 square miles. Now if his identification of the Permian and Triassic was in each case an error, what shall we say of the 500,000 square miles? and what of his map, if this is all wrong, and in addition his identification of Triassic in the Lake Superior region? He cannot rightly shield himself behind any geologist, or the common usage of following the best compiled results for fixing the lines.

Theoretical inferences may be good by way of suggestion; but too eagerly followed they lead to just the errors Mr. Marcou has made. But his system for the West has not even the show of probability in its favor. It is well known, and Mr. Marcou admits it, that Cretaceous fossils and rocks occur about the very summit plains of the Rocky Mountains. The natural inference is, therefore, that when in Cretaceous times these summits were under water, the sea also extended over what are now the eastern slopes of the mountains, and might have covered them with Cretaceous beds: and that thus the Cretaceous should be expected to be the surface formation, (it is understood that the question relates to the *surface* formation, as the colors refer in all cases to this,) and that any Jurassic, Triassic, and Permian, if they exist, should be covered up by it. This, I say, is what should naturally be expected. Moreover, this is what all researches since Mr. Marcou was over the region are tending to prove; they sustain Hall and others in coloring the greater part of the Rocky Mountain slope Cretaceous. The inferior beds, as the Palæontologist quoted from in my paper states, may be looked for as outcropping beds about the base of the ridges or crests of the mountains. Mr. Marcou's map is hence not only at variance with recent researches, but also with reasonable views of western geology.

We cannot see therefore that Mr. Marcou's claims as a discoverer are in any one case sustained, or that his merits are in any respect enhanced by his American researches. And we certainly should not go to him for an exposition of American geology.

Professor Agassiz knows well our American geologists and appreciates their labors; and he writes about them in a different style from Mr. Marcou. But on this point it is not necessary to dwell.

2. *On some points in American Geological History*; by Prof. James M. Safford, of Tennessee.—The Lower Silurian rocks of East Tennessee afford several very interesting local beds. Among them there are two which I desire to mention with reference to their bearing upon American Geological History. The first and oldest is a bed of crinoidal variegated Marble: the second is a bed of sandy *ferruginous* Limestone of peculiar aspect. The Marble (measured not far from Knoxville) is nearly 400 feet thick; the ferruginous bed is thicker and sometimes rests upon the former, but is generally separated from it by a few feet of calcareous shale. The whole is overlaid by limestones and calcareous shales of the Hudson period.

The geographical extent and range of these beds is peculiar, and to my mind, indicates the early Silurian age of the Appalachian oscillations. It is easily shown, that, before they had partaken of the later and Appalachian movements, these beds were long and narrow belts stretching to the

northeast and southwest. The Marble, for instance, ran from Virginia, through Teneessee, to Georgia, a distance of more than one hundred and fifty miles. How much further it extended lengthwise beyond the limits of Tennessee, I know not. Yet with this length its greatest breadth was not more than twenty miles. There can be no question as to the belt-like character of this bed when *first* deposited. Although broken and dislocated by after movements, the original thinning out of the bed laterally is clearly seen in good sections.

The ferruginous bed commenced within the limits of Tennessee, a few miles above the present site of Knoxville, and ran down into Georgia. Its length in Tennessee was not less than 100 miles. How far it extended southwestward into Georgia, I have not ascertained. It covered a somewhat wider area than the marble, but had very much the same long belt-like character.

To what now is the long narrow form of these beds to be attributed? and why did they, or do they, conform in direction to the great Appalachian folds? and why did they thin out on both sides much after the same manner, there being, at this period, no greater indication of dry land on one side than on the other? It appears to me that your view of the Silurian age of the Appalachian oscillations will alone satisfactorily account for these characters. By them the sea-bottom was arranged (perhaps in a long trough) first for the crinoidal grove, the remains of which, together with small corals, (Chaetetes,) form the Marble bed. Afterwards by other oscillations the bottom and the sediment were prepared for the ferruginous bed, &c.

There are other facts bearing upon this subject, which I have observed in the Lower Silurian rocks of East Tennessee, but which time will not permit me to refer to at present.

3. *Post-Pliocene of Lewiston, Maine.*—Mr. W. W. Baker gives an account in the Proceedings of the Boston Soc. Nat. Hist., 1858, p. 394, of the occurrence of a fossil starfish in a hill of earth, 30 miles from the sea, 200 feet above its level, 100 feet above the level of the Androscoggin, which is half a mile off, and 10 feet below the present level of the surface. The hill is clay for eight feet, then thin layers of sand, gravel and clay, alternating. The species according to Mr. Bouvé, was the same as the living species of the coast. There were also numerous impressions of shells.

4. *Untersuchungen über die Entwickelungs-Gesetze der organischen Welt, während der Bildungs-Zeit unserer Erd-Oberfläche*, by Dr. H. G. Bronn: 502 pp. 8vo. Stuttgart, 1858.—This work is a general review of the progress of life in the course of geological history. It received the prize from the French Academy in 1857.

5. *Further Contributions to the Palæontology of the Tilestones or Silurio-Devonian Strata of Scotland;* by Mr. D. Page, (Proc. Brit. Assoc., Ath., No. 1616).—Without entering on the stratigraphical relations of these tilestones (which would be discussed at a subsequent meeting), he might simply mention that part of them, as in Lanarkshire, seemed to cap and form portion of the Upper Silurians, while the larger portion, the Forfarshire flagstones, undoubtedly constituted the basis of the Old Red Sandstone; hence, with a view to avoid all discussion in the mean time, he had ranked the whole as "Silurio-Devonian." Beginning

with the Lanarkshire beds, he had, since the Glasgow meeting, been enabled to add several new forms to the fossil Fauna of that district, for hitherto no trace of vegetation had been detected in the strata. In addition to *Trochus helicites* and *Lingula cornea*, which were then known, he had now to add Pterinea, Orthonota, Nucula, Avicula, Orthoceras, and other well-marked Ludlow or Upper Silurian shells. To the Crustaceans then known, viz., Beyrichia, Ceratiocaris, and Himanthopterus, he had now to add several discoveries which rendered the structure of these curious crustaceans more apparent, besides the detection of two entirely new forms, which he would venture to term provisionally *Eurypterus spinipes* and *E. clavipes*, in allusion to the characteristic form of their swimming paddles, or third pair of organs which spring from the under side of their cephalothorax. Turning to the Forfarshire beds, which in 1855 were known to yield little more than obscure vegetable forms, *Parka decipiens* of Lyell, Pterygotus, and Cephalaspis, he was now enabled to add several new and gigantic forms of Fucoids, a Cyclopteris, and a Lepidendroid stem, which was clearly of terrestial origin. To the Fauna he has added gigantic Scolites or annelid burrows, Serpulites or annelid tracks, and an organism which appeared to be the remains of an annelid itself. There had also been discovered several new portions of Pterygotus, which rendered the true structure of that gigantic crustacean much more apparent; and he had also been enabled to describe and figure two new crustaceans under the names of Kampecaris and Stylonurus, the latter closely related in structure to Eurypterus, and approaching the forms of those found in the Lanarkshire strata, To Cephalaspis, of which little more was known than the head and bony ring-plates of the body, he had now to add a well-marked corneous eye-capsule, a pair of pectoral fins, a dorsal fin, and the true form of the large heterocercal tail,—so that, instead of figuring this much-caricatured fish as had hitherto been the case, as a saddler's knife for the head, and a parsnip with a few radicles for the body, we could now restore it as a legitimate and elegant fish, much resembling in general contour the armed bullhead or Aspidophorus of our present shores. There had also been discovered a vast number of fin-spines or Ichthyodorulites, which were yet undescribed, and a small fish with fin-spines and shagreen-like scales, to which he had given the name of *Ictinocephalus granulatus*, in allusion to its kite-shaped head and shagreen-covered body. For the discovery and preservation of these new fossil forms, palæontologists were mainly indebted to James Powrie, Esq., of Reswallie, Forfar, and to Mr. Slimon, surgeon, Lesmahagow, to the latter of whom the British Association, on the representation of Mr. Page, has given a grant of 20*l*., to assist in prosecuting his researches among these interesting but as yet partially explored strata.

III. BOTANY AND ZOOLOGY.

1. *Nereis Boreali-Americana; or Contributions to the History of the Marine Algæ of North America;* by William Henry Harvey, M.D., M.R.I.A., F.L.S., Professor of Botany in the University of Dublin, etc. Part III. *Chlorospermeæ.* (Smithsonian Contributions, for 1858). Pp. 140, tab. 37–50, imp. 4to.—Our readers are familiar with the first part of this elaborate work, containing the *Melanospermeæ* or olive-colored

Algæ, and with the second, the *Rhodospermeæ*, or rose-red series. With the *Chlorospermeæ*, or proper green Algæ, Dr. Harvey has now completed this extensive undertaking, and furnished us with a manual of the highest character, by which the marine Algæ of our continent,—and also a good part of the fresh-water species—may be readily studied. Great praise and cordial thanks are due to Dr. Harvey for the prolonged and assiduous labors which have fairly opened this wide and difficult field to the American student; and likewise to the Smithsonian Institution, for its enlightened liberality in the publication, not only presenting copies to all the principal public libraries of the world, but placing a separate edition upon sale at a low price, which brings the work within the reach of every earnest student or zealous amateur in the country. We are gratified to learn that the enterprise and good judgment of the managers of the Institution are duly appreciated by the public; and that the work has achieved a popularity unsurpassed by any of the valuable Smithsonian Contributions to Knowledge.

No good account of the *Chlorospermeæ* could be given without some view of the fresh-water species also. So, as many of these as was possible under the circumstances, have been included in the present memoir. But a large part of them can be investigated only when alive. Also the *Diatomaceæ* and *Desmidiaceæ*, although they systematically belong to the *Algæ*, yet they form a microscopic world of themselves, and require a separate treatment by a special monographer. The accomplished naturalist upon whom this task appeared to devolve, and who, indeed, had done much towards its accomplishment, is no more; he of whom our author feelingly writes, in the following extract.

"I must therefore leave the task of [more fully] describing the fresh-water *Algæ* of America to other hands;—to some one living among them; and having eyes fully open to the difficulties of his task, and zeal and ability to work it faithfully. And here I cannot omit a slight tribute to the memory of one in whom were combined, in no common degree, the qualifications which make an able naturalist, and who, had he lived, would probably have taken up the broken thread. I allude to the late Professor J. W. Bailey, of West Point, one of the earliest explorers of American *Algæ*, and whose very able memoirs on the *Diatomaceæ* have won for him an imperishable name in the annals of science. To me his loss is more personal than to most of his botanical friends; for, from the hour we first met there grew up between us a warm friendship, which death has interrupted, but which I trust it has not ended. He it was who first suggested to me a memoir on the American *Algæ*; he arranged with the Smithsonian Institution the terms of its publication; he supplied me with a multitude of specimens; and to his influence I owe the assistance I have received from many American algologists, who looked up to him for direction in their studies. He was, as far as the Algæ are concerned, my chief American referee, to whom I could apply when seeking information on local matters connected with this branch of study. With him I constantly associated my work, and to his approbation I looked forward as the most grateful reward of my labors; and now that he is removed, my interest in the work has sensibly flagged, and I am not sorry that it is brought to a conclusion."

A passing tribute is paid to the memory of another contributor, the late Professor Tuomey of Alabama; and his name is commemorated in one of the two new genera described in the present part. ***Tuomeya fluviatilis*** is a fresh water plant, resembling a *Lemanea* in external appearance, but very different and not a little curious in anatomical structure.

The other new genus, ***Blodgettia***, is named for the late Dr. Blodgett of Key West, who had zealously collected the Algæ as well as the other plants of the Florida Keys.

The structure of ***Blodgettia confervoides*** (which is illustrated in one of the plates) is so extraordinary and unexpected, that we are tempted to copy the account of it. Briefly, the cell-wall of its unicellular joints is "formed of separable membranes, the outer of which are hyaline and homogeneous, the innermost traversed by parallel, longitudinal, anastomosing veinlets. Spores seriated in moniliform strings, developed from the veinlets of the inner cell-wall!" The following is the detailed account.

"The highly curious little Alga on which the present genus is founded so closely resembles a Cladophora that it will readily pass for one, unless it be very closely examined under a powerful microscope. Indeed so great is the resemblance to a branched Conferva that I formerly distributed it to my friends with the manuscript name of Cladophora cæspitosa, under which it was my intention to have described it in the present work; nor did I discover my error until I commenced making sketches for the plate now given. I was then first struck by the peculiar opacity of the dissepiments; and afterwards by what looked like a compound cellular structure in the walls of the cells.

On applying a higher power, other characters came out which induced me to dissect one of the articulations, when I discovered the curious structure of the inner membrane or primordial utricle; in which (as far as I can make out) the spores are developed. To see the structure as above described, the readiest mode is to proceed as follows. Cut off a portion of one of the long cells which terminate the branches; place it on the table of a dissecting microscope, moisten it, and you may readily express the viscid endochrome, which generally contains, besides the usual starch and chlorophyll grains, a number of pyramidal crystals; but these are probably adventitious. When the endochrome has been pressed out, the structure of the inner cell-wall may be partially seen; but to see it clearly, the outer coats must be removed. This may readily be done, either by tearing, with a pair of dissecting needles, or by making a longitudinal section through the cell, when the different coats easily separate, on the section being *teased* in a drop of water. The outer coat, coats (for there are two or more, though the secondary ones sometimes elude detection, owing to their extreme tenuity) are quite transparent and structureless, as is usually the case in the walls of cellular tissue. But the inner coat offers a peculiarity of structure which I have not noticed in any other Algæ, nor have heard of its occurrence in the cells of any other plants. At first sight the membrane seems to be composed of numerous minute, elongated fusiform cellules, not unlike the wood-cells of phanerogamous plants, but totally unlike any algæ cells known to me. Careful examination has however convinced me that the appearance of cellular

structure is deceptive; and that the membrane itself is homogeneous, but traversed by slender filiments or nerves, which anastomose together, forming areolæ which look like cells. These filiments give off *free* ramuli whose apices swell into spores; and (probably) by repeated cell division produce the strings of roundish *spores*, which are so conspicuous in most of the areolæ. The appearance of the whole membrane with its spores is as if a number of the *asci* of a lichen were placed side by side; the true structure, however, I need hardly say, is widely different."

Truly nature revels in variety, in the lowest and simplest, even more than in the highest tribes of plants. *Hydrodictyon*, or the Water-net, affords another, and a more familiar illustration of this, being a viviparous Alga. While in a *Conferva* a zoospore develops into an individual which increases in dimensions by the multiplication of its cells, in *Hydrodictyon* a great number of zoospores combine to form one individual, composed of a definite number of cells which remain unchanged, until each cell gives birth to a new *Hydrodictyon* complete.

"In all stages the *Hydrodictyon* is a bag-like or purse-shaped net, with generally five-sided meshes,—each mesh consisting of a single articulation or cylindrical cell, united by its ends to the neighboring cells, ... and from first to last carrying on an independent existence. When first emitted from the parent, the young *Hydrodictyon* is of microscopic size. It grows rapidly until each articulation becomes from a quarter to half an inch in length, and half a line in diameter. Up to this period the cells are filled with a green semi-fluid endochrome, in which grains of different sizes are formed. Gradually this green matter is resolved into an infinite number of minute zoospores, which are at first spherical, afterwards ovate, pointed at one end, and which, while contained within the cell-wall, exhibit lively movements. At length these movements gradually subside, and the zoospores arrange themselves, end to end, into polygonal, commonly pentagonal areolæ; and when all the zoospores contained within a single articulation have so arranged themselves, the little net is completed before its emission or birth. When all is thus ready the parent net falls to pieces, each articulation floating separately; and shortly afterwards, on the bursting or deliquescence of the wall of the mother-cell, the little net work floats independently, and commences its career of growth and development."

Here only the spores or germs are active; the developed plant vegetates quietly. But in the Oscillatorias, which are described a little further on, the mature plant exhibits very *animated* movements. "Some have a rapid progressive and regressive movement, by which they can change their place, rising or falling in the water; others, while remaining nearly in one place, move from side to side, describing an arc. The genus *Oscillatoria* is so named from the pendulum-like movements of its filaments. Species of this genus are to be found in most pools of stagnant water, and their peculiar movements may be easily observed. These plants occur, when fully developed, in floating, skin-like, slimy pellicles, of a deep green, or blackish, or bluish color, and a gelatinous substance. If a small portion of the floating scum be placed in a cup of water, and allowed to remain for some hours at rest, its edges will become finely fringed with delicate, radiating threads, which extend further and further

from hour to hour. . . . . The filaments have merely spread out, not grown, by means of their peculiar movements. These movements are of three kinds; first, there is the oscillating movement, one end of the thread remaining nearly at rest, while the other sways from side to side, sometimes describing nearly a quarter of a circle in a single swing. Secondly, the tip of the filament has a minute movement, bending from side to side, like the head of a worm; and thirdly, there is an onward movement, probably the result of the two former. It is this latter which causes the filaments to radiate, and spread out from the edges of the stratum."

But we must refer the curious reader to the work itself, which, though framed on a systematic and strictly scientific basis, is yet replete with physiological matters of general interest. We could have wished for a detailed account of the recent discoveries, by Pringsheim and others, of the sexual fertilization of the spores of the lower Algæ, which takes place in a variety of wonderful ways. Reference, however, is made to the original memoirs, of which, indeed, some abstracts have been given in former volumes of this Journal.

The plates, although, from the nature of the subjects, not as showy as those of the second part, are handsome and admirable. A. G.

2. *Species Filicum; being descriptions of all known Ferns. Illustrated with plates;* by Sir WILLIAM JACKSON HOOKER, K. H., &c. London: 1858. William Pamplin. Parts VII and VIII, or Vol. II, Parts III and IV. 8vo, pp. 250, tab. 111–140.—The publication of this work is resumed after an interval of six years. This delay, we are told, "has been a source of great regret both to the author and to the publisher, and has been, in a measure, occasioned by the great difficulty and labor of the subject in hand,—especially in a genus so extensive as that which occupies nearly the whole of the portion now issued, viz., *Pteris.*" Besides *Pteris* the author has here elaborated *Llavea, Cryptogramme, Pellæa* and *Ceratopteris. Llavea* consists of a single Mexican species separated from *Pellæa* by habit rather than by any characters of fructification. *Cryptogramme* is also considered as monotypic, *C. crispus* being made to include the East Indian *C. Brunoniana*, and the North American *C. acrostichoides.* The older name of *Allosorus* is rejected both for this genus and for *Pellæa* on account of the vagueness of its character, as originally drawn up by Bernhardi; '*Sporangia cathetogyrata, sessilia, sub-aggregata. Hyposporangia sub-communia, margine libero, sub-pellucida;*' and because it "has been made a receptacle for Ferns of very varied structure, according to the different views of authors respecting the limits of the genera, especially of those included in this work under the name of *Pellæa.*" The genus *Pellæa* was proposed by Link in 1841, adopted by Fée, in his Genera Filicum, and here accepted by Sir William Hooker. It includes thirty-three species, of which one third are found in the United States, viz., *P. gracilis* in the Northern States; *P. atropurpurea* from Vermont to Texas; *P. Bridgesii* and *P. densa* in California; and *P. cordata, P. flexuosa, P. andromedæfolia, P. pulchella, P. Wrightii, P. longimucronata* and *P. Orithnopus* in the region between Texas and California. The last three species are probably but forms of one, which must bear the name of *P. mucronata.* [*Vide Botany of Mexican Boun-*

Survey.] Under the genus *Pteris* the author remarks: "It will be from the characters and the references given, that I have taken the step, and what many will consider a retrograde movement in bota- n restoring almost entire the original Pteris of Linnæus and Swartz Willdenow." Reviewing at some length the various modern genera, pteria, *Litobrochia*, *Doryopteris*, *Heterophlebium*, *etc.*, into which va- authors have divided the Linnæan *Pteris*, he concludes with the on that "as new light is continually being thrown upon this family ints, it is premature to sanction the great multiplication of genera by g stress on the nature of the venation when unaccompanied by any sponding changes in fructification, or any marked differences in habit, more philosophical to consider such groups in the light of sections bgenera. The importance of the vascular structure is acknowledged; rangement, to say the least, equally natural, is preserved, and some e of stability is given to names invented and sanctioned by the most ious botanists that ever lived." This mode of regarding *Pteris* is tly in accordance with the way in which *Lindsæa* and *Adiantum* treated in the earlier part of the work, and on the whole must re- iend itself to the student of general descriptive botany. The inves- r of a single natural order is peculiarly liable to commit the fault essive subdivision, while a botanist, like Sir William Hooker, emi- in all departments of his science, will naturally take wider, not to under, views of the limits of genera and species. One hundred and y-three species of Pteris are admitted, not including a large number scure species, of which no notice is taken, and the fifteen or twenty ial species, which are reduced to the cosmopolitan *Pteris aquilina.* opteris thalictroides, Brongn., after having been referred to five differ- borders by various botanists, and by one even excluded from the altogether, is here associated with *Pterideæ*, not from any real sim- of structure and habit, but because no better place has been found

We may remark in passing, that it is not quite correct to say, as ge 155, that Agardh excluded only the *Allosori* of Bernhardi and from the Linnæan *Pteris*, since in fact, he excluded all those that s called "*Adiantoideæ*;" among them, *P. pedata*, the type of Mr. ith's genus, *Doryopteris*. *Pteris dispar*, Kunze, in *Bot. Zeit.* 6, p. s evidently the same plant as *P. semipinnata*, var. β, and should been given as a synonyme of it. An advertisement affords the ing intelligence that the first part of the third volume may be ex- at an early day. D. C. E.

Catalogue of North American Birds, chiefly in the Museum of the sonian Institution, by SPENCER F. BAIRD, Assistant Secretary of the sonian Institution.—This Catalogue by Prof. Baird, enumerates 738 of birds, of which all but 22 are strictly North American. All 8 were determined from specimens, excepting 31. Wilson's work 4 contained 283 species, Bonaparte's in 1838, 471 species, and on's in 1844, 506 species. The catalogue therefore contains nearly lf more species than Audubon enumerated. The Catalogue is lly valuable as a list of well ascertained localities, thereby indi- the range of the species. The author's habitual care and untiring research authorize full reliance on its accuracy.

4. *Odontology*, by Prof. OWEN.—A very extended article of great value on Teeth, very fully illustrated, is published by Prof. Owen, of London, in the 16th volume of the Encyclopedia Britannica (8th edition). It takes up the whole range of vertebrates and includes both fossil and recent species among its illustrations. The wood-cuts, of which there are near 200, are excellent and highly instructive.

IV. ASTRONOMY.

Donati's Comet, or the Great Comet of 1858.—In our last number we were favored by Prof. Wm. C. Bond, of the Observatory of Harvard College, with a brief notice of this splendid Comet. In Runkle's *Mathematical Monthly*, Nos. 2 and 3, (Cambridge, Mass. Nov. and Dec. 1858,) Mr. Geo. P. Bond, of the same Observatory, has published a highly interesting and valuable account of this body. Rarely has so fine an opportunity been presented for observing the physical constitution and internal changes of a comet, and the opportunity has been well improved. The second part of Mr. Bond's paper occupies 26 pages and is enriched by numerous wood-cuts, and by two engraved telescopic views of extraordinary beauty. We cite a few passages from this important memoir, and hope that our readers will procure and read the full account.

"The interest of the telescopic view, taking all the circumstances into account, the size of the instrument, the perfect purity of the atmosphere, and the splendor of the object, have rarely been surpassed. The nucleus and the outline of its nearest envelope were visible in full sunshine with the large telescope. The head of the Comet could be seen with the naked eye at twenty minutes after sunset, at which time the second envelope was discernible with the telescope. It is most remarkable, that, with all this accession of brightness, the nucleus itself had now diminished to a diameter of only four or five hundred miles, scarcely one fifth of what it was on the morning of the 9th of September, by a very careful determination. Its volume had thus diminished to *one-twentieth* part only. The remaining nineteen-twentieths had, in the intervening period, expanded into the tail, or had gone to form the envelopes which now encircled it, by a process which has been fully illustrated in the preceding pages. But are we then to conclude that the nucleus, in the focus of these mysterious operations, had in this way expended the greater part of its substance? To this inquiry the best reply is a consideration of its subsequent condition. After several more eruptions from its surface, similar to those above described, it receded from our view about the 20th of October, with an evident *increase* of size compared with its condition two weeks before, and still shining with its accustomed intensity."

"Examined in the day time on the 5th with the highest powers which it would bear, no indication of a *phase* could be seen. * * "

"The tenth of October was the day of nearest approach to the earth, but the comet was manifestly on the wane, though expanded over a larger extent of the sky than before. Five envelopes, reckoning the exterior haze as one, could be traced through the whole or some part of their outline."

"We must add a few words on the appearance presented by the tail *between* the 6th and the 10th of October. At the date first named, one

of the supplementary rays, attained a distance of 55° or fifty millions of miles from the nucleus, somewhat exceeding that of the principal tail, and in a direction as usual, nearly in a line from the sun. Others less perfectly developed could be discerned near a point where the curvature of the main stream was pretty suddenly changed. On the 8th five or six transverse bands could be distinguished in the tail half a degree or less in breadth, with clear, well-defined outlines, and perfectly resembling auroral streamers, excepting that they kept their position permanently, that is, without motion sensible to the eye, they diverged from a point between the sun and the nucleus."

"The train attained its largest apparent dimensions on the 10th, when the main stream of light could be distinguished through an arc of 60°, corresponding to a length of fifty-one millions of miles, or rather more than half the distance of our earth from the sun. The distribution of its light at a distance of 20° or 30° from the nucleus in parallel or slightly diverging bands, alternating with dark spaces, was strongly exhibited. They were 5° long, and 20′ or 30′ wide, and might aptly be compared either to the streamers which often break up the continuity of an auroral arch, or to a collection of five or six tails of small comets, forming from the remains of the large one."

"The most recent intelligence leaves no room to doubt that the comet of Donati is periodical, having a time of revolution of about two thousand years. The following are the results arrived at by different computers:—

Watson,	- - - - - - -	2415 years.
Bruhns,	- - - - - - -	2102 "
Löwy,	- - - - - - -	2495 "
Graham,	- - - - - - -	1620 "
Brünnow,	- - - - - - -	2470 "
Newcomb,	- - - - - - -	1854 "

"Supposing its last perihelion passage to have occurred at the beginning of the Christian era, it must have passed its aphelion in the early part of the tenth century, at a distance of 14300 millions of miles from the sun, its velocity at that point being 480 miles an hour."

V. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *Tables, Meteorological and Physical, prepared for the Smithsonian Institution;* by ARNOLD GUYOT, LL.D. 2d edition, revised and enlarged. Washington, Smithsonian Inst., 1858, 8vo.—The full value of this extensive and important collection of tables it is impossible to exhibit without a detailed catalogue, which our limits do not permit. They are selected from a wide range of authorities, by a gentleman who is well known for his thorough acquaintance with the best sources of knowledge on these subjects, and for his faithful and exact computations. The amount of labor demanded for the preparation of the work must have been great, and the scientific men of all countries are under weighty obligations to the accomplished editor, and to the Secretary of the Smithsonian Institution for making accessible at so cheap a rate, so precious a collection of auxiliary tables.

A first edition of part of these tables appeared in 1852. More than three times as much matter is contained in the present volume, as in the former issue.

The work now comprises six series of tables, viz.:

I.	Thermometrical,	15 tables, in	35 pages.
II.	Hygrometrical,	33 " "	165 "
III.	Barometrical,	28 " "	134 "
IV.	Hypsometrical,	26 and 44 "	149 "
V.	Meteorological Corrections,	99 tables "	120 "
VI.	Miscellaneous,	6 " "	12 "

The following remarks are made by Prof. Guyot in respect to the construction of these tables:

"In the Thermometrical series six small tables have been added; they were prepared for converting into each other differential results given in degrees of any one of the three thermometrical scales, irrespective of their zero point.

"The Hygrometrical series has been entirely reorganized. It only contained five tables, all in French measures, and the appendix. It is now composed of twenty-seven, arranged in three divisions. In the first are found ten tables, based on Regnault's hygrometrical constants, both in the psychrometer, the dew-point instruments, and for computing the weight of vapor in the air. The whole set in English measures, and Table V in French measures, have been prepared for this edition. Being based on the best elements we now possess, they are given here for ordinary use. The second division contains the seven most important tables published in the *Greenwich observations*, and Glaisher's extensive Psychrometrical Table. These tables being much used in England, and the results obtained by them exhibiting no inconsiderable differences from those derived from the preceding ones, they are indispensable for comparing the results. The third division, composed of ten miscellaneous tables, furnishes the means of comparing the different values of the force and the weight of vapor, especially those which have frequently been used in Germany, and also of reducing the indications of Saussure's Hair Hygrometer, to the ordinary scale of moisture. The appendix remains as in the first edition, but all the tables have been revised and corrected.

"The barometrical series now in four divisions, has been increased from twelve to twenty-eight tables. Excepting three small tables for capillary action, all the new ones have been computed for this edition. The comparison, now so much needed, of the Russian barometer with the other scales, appears here for the first time.

"The Hypsometrical series is almost entirely new. It contained only Delcros's table for barometric and Regnault's table for thermometric measurements, besides two auxiliary tables and the thirteen small tables of the appendix. It now offers twenty-three tables for barometrical measurement of heights, in which all the principal formulas and scales are represented; three for the measurement of heights by the thermometer, in French and in English measures; and a rich appendix of forty-four tables, more extensive and convenient than those in the old set, which afford the means of readily converting into each other all the measures usually employed for indicating altitudes.

"The series of Meteorological corrections for periodic and non-periodic variations, for all parts of the world, mostly due to the untiring industry of Professor Dove, is an addition which will surely be appreciated by those who know how difficult access to the original tables is for most meteorologists. A few tables have been added to Dove's collection, computed by Glaisher, Captain Lefroy, and by myself. Most of the tables refer to temperature, only two to moisture. Two tables of Barometrical corrections have been placed in the Hypsometrical series, where they were needed, until they can be joined by others to make a set in this series, which still awaits new contributions, especially for these two last departments."

2. *On the Heating of the Atmosphere by Contact with the Earth's Surface;* by Prof. HENNESSY, (Proc. Brit. Assoc.. Ath., No. 1616).—The temperature of the atmosphere depends principally on the heat which it receives from the sun and on what it loses by radiation. A portion of the solar heat is absorbed in passing through the air, while another portion penetrates to the earth's surface. The ground becomes thus heated, and the lower strata of the atmosphere acquire the greater part of their heat from contact with the warmed surface. It is admitted that the mode in which the air becomes heated by contact with the ground must be a kind of circulation analogous to that seen in the movements of a heated mass of liquid, such as boiling water. When studying the vertical movements of the atmosphere, with reference to which Prof. Hennessy had made a communication to the Association last year, he had been led to consider the connexion between such movements and the influence of the heated ground. In order to experimentally study the question, thermometers were suspended at different heights above the ground, and under different circumstances of exposure to the influence of the supposed currents. Observations were made every minute, and sometimes every half minute, during short intervals, about the middle of the month of May, on days when the sky was clear, and during which there was consequently a great deal of solar radiation. In general the thermometers exhibited fluctuations of temperature, the intensity of which diminished the more they were protected from the influence of circulating currents in the air. The greatest fluctuations were presented by thermometers with blackened bulbs exposed in the sun. This arose from the circumstance that the blackened bulbs, by acquiring a high temperature, became themselves disturbing agents in the calorific conditions of the surrounding air. Evidence of similar phenomena appears to be presented by the curves of temperature obtained by the aid of photographical registration at the Radcliff Observatory in Oxford. Attention has been called by Mr. Johnson to a remarkable serration in the temperature curves during the day. This serration is found only when there is a considerable amount of solar radiation, it disappears during sunless and cloudy weather. While it is explained by referring it to the influence of the solar heat upon the ground, and the consequent circulation of small atmospheric currents, it affords a very satisfactory confirmation of the trustworthiness of the photographical method of registration.

3. *On the Decrease of Temperature over Elevated Ground;* by Prof. HENNESSY, (Proc. Brit. Assoc., Ath., No. 1616).—He showed that the

decrease of temperature in ascending through the atmosphere depended not only on height above the sea level, but also upon the absolute height above the nearest surface of solid land. In this way the decrease of temperature over plains, mountains, and plateaus, would be necessarily very different, and we cannot immediately infer the state of the phenomena in the two latter instances from what may exist in the former. Some of the results of observations made on some of the hills and mountains of Ireland during the Ordnance Survey, as contained in the volume recently published by Col. James, were referred to as illustrations of these general views.

Admiral FitzRoy thought that one circumstance was too much overlooked by Prof. Hennessy in these researches, namely, that along with these ascending currents the whole body of the air was carried along by horizontal currents, so that it could not be assumed that it was the very same air which gave some of the indications which afforded the others. Again, it had been clearly shown that a thermometer placed upon the ground, or close to it, frequently fell 17° or 18° below one placed a few feet or inches above it, while somewhat higher up still, the indications of the thermometer again fell, thus clearly indicating a spot at which there was a maximum temperature. As to the latter part of what he stated, it was so commonly observed that if you placed a thermometer in the lower window of a house, and another in the window immediately above it, in nine cases out of ten you would find the latter indicate a lower temperature than the former. Prof. Stevelly said that, besides what Admiral FitzRoy had pointed out, there were two other circumstances of much importance to be attended to in such observations as Prof. Hennessy had been making. First, that evaporation was going on more or less rapidly according to the circumstances of the locality where the observations were conducted. Secondly, that the air, when having,—either gradually, as in some cases, or abruptly, as in others,—to ascend in its course very elevated ground, was compelled to contract in volume, become condensed, and yet in some cases part with a portion of its vapor, and thus form the cloud which we so often saw capping the hills, as well as giving origin to the high winds and storms which so frequently prevailed there. Dr. Tyndall said that he had just returned from Switzerland, where, on the tops of Monte Rosa, and even of Mont Blanc, he had a full opportunity of witnessing these phenomena on a scale of grandeur truly sublime. The snow in these regions was naturally as dry as dust, and he had frequently an opportunity of witnessing columns of it whirled up to an immense height by the ascending currents of air, into regions where it was soon dissipated, or melted and dispersed into vapor. It was also to be observed that the sun's heat had a power of penetrating water and other screens, such as the clouds formed, far surpassing that possessed by heat derived from less intensely ignited or heated sources, as for instance, from bodies heated red hot, or from vessels filled with hot water and the like. Hence, the sun's rays, though they penetrated the clouds and the earth, yet there they totally lost their former powers, and when radiated back possessed no such power as before of penetrating clouds or other screens, and thus the earth and its atmosphere became a kind of trap for the solar rays.

4. *Death of Gen. Sir William Reid, R. E.*—Late advices from England bring us the sad intelligence of the death of this eminent man, which took place at his residence in London on the 31st of October. His departure is a loss, not merely to the country in whose service his life was spent, but to the world. His modest, unobtrusive worth, his unfaltering courage, his untiring industry, his disinterested efforts to promote the welfare of his fellow-men, and his valuable contributions to our knowledge of the winds, all demand more than a passing notice of his death.

Sir William Reid was born at Kinglassie in Fifeshire, Scotland, in 1791, and was the eldest son of the Rev. James Reid, a clergyman of the Scotch Church. He was educated at the Military Academy at Woolwich, England, and entered the British army in 1809 as an engineer, and served during the last four years of the Peninsula war, under the Duke of Wellington. He was actively engaged at the seige of Ciudad Rodrigo and St. Sebastian's. In the sanguinary assault upon the latter fortress, he headed one of the storming parties, was wounded by a musket ball, and fell, covered with blood, which streamed from his mouth and nostrils. He was supposed to be dead, but, on removing from his neck a black silk handkerchief (which, by advice of a medical friend, he had unwillingly assumed, instead of the stiff military stock), it was found pressed into the wound; and on using a little force to withdraw it, the ball came out with it, not a thread of the handkerchief having been severed. The removal of the handkerchief revived him, but the surgeons, on examination pronounced the wound mortal. Contrary to their expectations, he recovered. He was wounded four times during this war, and had three horses shot under him.

After the conclusion of the peace with France, he served on the coast of America, under Gen. Lambert, until the conclusion of the war here, when he rejoined the Duke of Wellington in Belgium, in 1815. In 1816 he served in the expedition against Algiers; was Adjutant of the corps of sappers for some years after the peace. Afterward, as a Major of engineers, he was employed in restoring the government buildings ruined in the destructive hurricane which devastated Barbadoes in 1831. While so employed, curiosity led him "to search everywhere for accounts of previous hurricanes, in the hope of learning something of their causes and mode of action, but in the West Indian histories he could find little beyond details of the losses in lives and property, and no attempt to furnish data whereby the true character or the actual courses of these storms might be investigated." While thus engaged, the first of the meteorological papers of our lamented countryman, Wm. C. Redfield, met his eye, being that published in the American Journal of Science in 1831. This he says, "was the first paper he had met with which appeared to convey any just opinion on the subject of hurricanes," and, strongly impressed that Mr. Redfield's views were correct, he determined to verify them "by carefully charting the observations made at different points." He soon became satisfied of the rotative character and determinate progress of the gales and hurricanes of the North Atlantic, as maintained by Mr. Redfield. In 1838, having been able to devote more attention to these inquiries, he published his first paper on hurricanes in the second volume of "Professional Papers of the Royal Engineers," and soon after having prepared

himself by a careful analysis of various hurricanes, he published his valuable work entitled "An attempt to Develope the Law of Storms by means of Facts, arranged according to place and time." Of this, three editions have appeared. Some years later (1849) he published a second work entitled "The Progress of the Development of the Law of Storms and of the Variable Winds, with the practical application of the subject to Navigation." By these labors, with those of Redfield, Piddington and Thorn, his principal co-workers, the power of knowledge has conquered even the hurricane, and the intelligent mariner, warned by indications of the barometer, and those of the early winds of the coming storm, may securely watch its approach, and avoid, in almost all cases, its dangerous vortex, and thus sail on unharmed by the gale—even while skillfully using its outer winds to expedite his voyage.

But his meteorological labors, valuable as they have been, formed but a portion of his usefulness. In 1838 he received, unsolicited, the appointment of Governor of Bermuda. On his arrival there in 1839 he found agriculture far behind; corn and hay were imported; there was but little fruit; bitter citron trees grew everywhere; and in sight of the government house was a wide swamp. Col. Reid set the example of improvement. He grafted a sweet orange on a bitter citron tree, in front of the government house; it bore good fruit, and soon all the bitter trees were grafted. He drained the swamp, imported plows and other improved agricultural implements from New York, had plowing taught, gave prizes for the best productions, and in 1846 held a grand agricultural *fete* in a fine dry meadow field—the old swamp. In fact, he gave new spirit to the people, showed them how to work out their own prosperity, changed the face of the island, took great interest in promoting popular education, in diffusing *temperance* tracts, and so won the title of "*the good Governor*," by which he is still affectionately remembered in Bermuda. In one of the volumes of Dickens' Houseword Words, the praises of this "Model Governor" may be found set forth.

In 1846 he was transferred to the Windward West India Islands, comprising Barbadoes, St. Lucia, St. Vincent, Grenada, Tobago and Trinidad. Here also, by his firm and beneficent conduct, he gained the confidence and good will of the entire population, and devoted himself, as he had done at Bermuda, to the welfare of his people and to their advancement in agriculture, education and temperance. He removed a judge who had used his power to oppress the people, and when the home government hesitated to give him their support in this, he promptly resigned his office, and returned to England in 1848. In 1849 he was appointed Commanding Engineer at Woolwich, and commanded the engineer officers and sappers and miners at the Great Industrial Exhibition; and on the resignation of Mr. Robert Stephenson, Col. Reid was requested by the Royal Commission to become, in his room, Chairman of the Executive Committee, in which capacity he served with unremitting attention. On the closing of his service for the Great Exhibition—for which he generously declined remuneration—he received the Order of Knighthood from the Queen, and in September, 1851, he received the unsought appointment of Governor of Malta—no idle appointment, for presages of the Russian struggle were even then flashing in the eastern sky, and the

government knew the value of the man they assigned to this most responsible post. During the eventful struggle which ensued on the banks of the Danube and in the Crimea, Malta was the chief point of embarkation of British troops. In February, 1854, Gov. Reid writes to a friend in this country, "I am preparing for the Russian *storm*—the first portion of 10,000 men from England having just now entered the harbor. I must in charity believe the Czar to be mad, thus to compel mankind to begin anew to destroy each other." He continued in this post until after the close of the Russian war, receiving meanwhile the promotion to General. Near the close of 1857, Lady Reid's health, which had suffered severely from the debilitating climates of the West Indies and Malta, forced her to return to England, and Gen. Reid, resigning his government, followed her as soon as a succession could arrive. Lady Reid lived but a short time after her return, and her husband has survived her but a few months. Gen. Reid had always greatly desired to make a friendly visit to the United States, but was never permitted that pleasure. Lady Reid, with two of her daughters, spent the summer of 1845 in this country, and those who had the pleasure of meeting her will not soon forget the charm of her vivacious and intelligent conversation. Gen. Reid has left no sons, but five daughters, two or three of whom are married to officers in the military and naval service of Great Britain.

We can hardly avoid noting here the remarkable fact that the spirit of this statesman and philosopher who had done so much to illustrate the path of the winds, should pass away, almost, as it were, on the wings of one of the most extensive, rapidly progressing and destructive ocean husricanes on record. First coming under notice at the Windward Islands about the 20th of October, it passed over Porto Rico, Hayti and the Bahamas; then recurving, its axis passed, on the 24th, nearly over Bermuda, where its violence was extraordinary; and thence for some days following, it pursued its course to the northeastward, almost or quite to the shores of Europe. No storm described by either Redfield or Reid seems to have had the enormous diameter of this. It was severely felt 700 miles eastward of Bermuda in the same latitude, while its western border grazed New York, affecting the barometer sensibly, and rolling in upon us the extraordinary tides of October 24 and 25.

5. *Journal of the Royal Dublin Society.* Vol. I. 441 pp. 8vo. Dublin, 1858.—This first volume of the Journal of the Royal Dublin Society contains a variety of valuable papers—among which, there are Captain F. L. M'Clintock's Reminescences of Arctic Travel, with a geological map and descriptions of fossils, by Rev. S. Haughton; several papers on British, Australian and South Pacific Crustacea, by Dr. Kinahan; Observations on the Climate and Zoology of the Crimea, by Mr. William Carte.

6. *Chimie appliqueé à la Viticulture et à' l'Œnolagie*, Leçons professées en 1856, par M. C. Ladrey, Prof. de Chimie à la Faculté des Sciences de Dijon, etc. 640 pp. 16mo.—This is an important volume to all cultivators of the grape as well as to those who manufacture wine from the grape. Professor Ladrey is an able chemist, and has prepared a thorough work. It treats of the growth of the vine—chemical composition of the ashes—nature of the soil—wine growing countries—fertilizers—organic matters of the vine—of grapes, their kinds, etc.—fermentation, etc.—diseases of the vine, etc.

7. *Post-Pleiocene Fossils of South Carolina;* by FRANCIS S. HOLMES, A.M. Nos. 1 to 5, in 4to, with two lithographic plates to each number. Price $2.00 per number.—This new work by Mr. Holmes, is published in the same style as the *Pleiocene Fossils*, and with similar beautiful illustrations. Figures of about 100 species are given in the 5 parts issued. The volume will be completed in 15 parts, 5 parts appearing annually. From Mr. Holmes we learn that the Post-pleiocene beds extend along the entire seaboard of the state of South Carolina, outcropping about 10 miles from the coast. At the Artesian well, in Charleston, the auger penetrated the stratum of blue mud containing Post-pleiocene shells at the depth of 21½ feet. There was first 2 feet of mud; then 2 feet or more of laminated blue sands and clays; then blue mud again, and so on for 49 feet 5 inches from the surface, when it reached the Eocene Marl. At Ashley Ferry, 10 miles northwest of Charleston, the stratum is only 1 foot thick, and rests upon Eocene Marl. The best locality is at Simmons's on Wadmalaw Sound, 10 miles from the sea-coast, as described in Tuomey's Geology of South Carolina, p. 189.

8. *The Medical Application of Electricity;* by WILLIAM F. CHANNING, M.D. Fifth enlarged edition. Boston: Thomas Hall, 158 Washington street, 1859. 12mo, pp. 242.—Dr. Channing's excellent little volume has been known for many years by its former editions. It enumerates a large number of diseases to which electricity in some form has been applied with more or less of success, with quotations of cases. In an appendix, Mr. Hall (successor to D. Davis, Jr.) gives his Illustrated Catalogue of Electromedical Instruments, so favorably known by the medical profession for their superior excellence.

9. *Treatise on the various Elements of Stability in the well-proportioned Arch, with numerous Tables of the Ultimate and Actual Thrust;* by Captain D. P. WOODBURY, U. S. Corps of Engineers. 438 pp., 8vo, with many plates and tables. New York, 1858: D. Van Nostrand.—Being No. 7 of papers on Practical Engineering published by the Engineer Department for the use of the officers of the U. S. Corps of Engineers.

10. *Maury's Sailing Directions*, Eighth edition, enlarged and improved. 383 pp. 4to, with numerous plates.

A. MALHERBE, of Metz: Monographie des Picidés, ou Histoire générale et particulière de ces oiseaux zygodactyles. This work will extend to 2 vols. fol. of text and 2 vols. fol. containing 125 colored lithographic plates and 700 figures. Only 150 copies will be published.

C. F. NAUMANN: Lehrbuch der Geognosie. Second edition, enlarged. 1st volume. xvi and 960 pp. 8vo, with 325 figures. *Leipzig*, 1858.

PROCEEDINGS BOSTON SOC. NAT. HIST., 1858.—p. 385, On the Species of Flying Fish along the coast of North America; *Weinland.*—On a new species of Skate, Goniobates, from the Sandwich Islands; *Agassiz.*—On a new species of Zeus, from Provincetown, Mass.; *Storer.*—p. 391, Notice of Dr. J. Deane; *Bouvé.*—p. 394, Fossil post-pleiocene Star fish, at Lewiston, Me.; *W. W. Baker.*—p. 395, Parasites in the American Deer; *Wyman.*—p. 396, Note on Crustacean Parasites from the Sun fish; *Kneeland.*—Feeding and Growth of the American Robin (Turdus migratorius); *Treadwell.*—p. 400, death of Dr. N. W. Cragin.

PROCEEDINGS ACAD. NAT. SCI. PHILADELPHIA, 1858.—p. 177, Description of a new Tanager, from the Isthmus of Darien, and note on Selenidera spectabilis; *John Cassin.*—p. 179, Description of a new species of Argyris; *J. C. Fisher.*—p. 180, Note on the species of Eleodes found in the United States; *J. L. LeConte.*

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[SECOND SERIES.]

ART. XVII.—*The Atlantic Cable;* by GEORGE MATHIOT, Electrotypist of the U. S. Coast Survey.—(In a letter to Prof. A. D. BACHE, Supt. of the U. S. Coast Survey, dated Coast Survey Office, Washington, Sept. 11, 1858).

As the Atlantic Cable has been laid for more than a month and the line is not yet opened to the public, it is evident that there is some great difficulty in the way. According to the newspapers the trouble is in the *recording* instruments. I fear, however, that such is not the true cause of the delay. I investigated the electrical conditions which would obtain in the cable as soon as I had procured a specimen of the material, and ascertained the electrical views entertained by the managers. From that investigation I positively predicted that the cable would be a failure unless other views of the generation and distribution of electricity should obtain in the subsequent management.

It is greatly to be regretted that the counsel of certain electricians prevailed in the construction of a cable having so small a conductor, and so thin an insulation. But now that it is laid, such as it is, at such immense labor and expense, in conjunction with fortuitous circumstances on the ocean, it becomes us to summon every aid of science and independently of theory to interrogate her *experiments* and hearken to the infallible directions which these give through the unerring calculus.

Experiment shows that an immense amount of electricity is disposed on the sides of the conductor before the current mani-

fests itself through it. Theorists attribute this delay solely to the circumstance of the electricity being thus disposed, and so leave us without a remedy. The investigations of Ohm, however, tell us that the time of conveying a given quantity of electricity between any two points is determined by the tension at those points and the resistance between, and hence we infer that if the sides of the wire must first be filled before any will pass through, then the time will depend on the quantity required, the tension at the source and the goodness of the conductor. Why should the mere circumstance of *where* the electricity is disposed cause the delay in its disposal?

I considered the electrical conditions for a submerged conductor on the first proposal for an ocean telegraph, and was so fortunate as to have a paper containing some of my deductions, published in the Coast Survey report for 1855. In that paper I described a voltaic experiment which proves that a battery requires *time* to generate the *quantity* of electricity required to produce the tension needed to overcome a certain resistance, and inferentially, that time is required for the *generation* as well as for the distribution of electricity. If you will turn to that paper you will there see foreshadowed all the present difficulties of the cable; so fully am I persuaded of the correctness of the principles there given, that I would confidently undertake to charge the cable in a very short time or extend the time of charge many minutes. In the limits of a letter I will not be able fully to lay open the principles which I conclude should govern the electricians of the cable, and fearing to intrude on your time I will proceed rapidly to elucidate the main points and describe what I would propose.

The difficulties of the "static induction" are all prevised by Ohm, and I cannot but wonder that the European electricians did not thence comprehend it; the delay of the current I thence anticipated before experiment had exhibited it. The fundamental principle of Ohm is that the quantity of electricity which passes between two contiguous particles in a given time is proportional to the difference of tension between them. Regardless of this fundamental idea of the distribution, the electricians of the cable have sought to work it as a simple problem of the conduction of a quantity through, as on fully insulated conductors (those suspended in air) instead of considering it as the problem of the charge and discharge of a Leyden jar (an unlimited number of momentary conducting lines): thus regarding the conditions of the flow of the current through the conductor, and ignoring the circumstances under which those conditions are established.

The *quantity* of electricity which a Leyden arrangement takes as a charge, is proportional to the intensity of the source, the

extent of surface, and the thinness and nature of the insulation, (the dielectric); the *time* required for charge is determined by the quantity to be conveyed, the resistance of the conductors and the difference of the tensions, and the further resistance due to a certain constant, dependent on the nature of the electric medium, (its coefficient of elasticity,) which is wholly undetermined so far, and probably can not be handled before we obtain conducting lines of many thousand miles in length, but which is so small that it may be disregarded in all practical applications of electricity: in which we may make the expression of the time the ratio of a fraction $\left(\frac{T-t}{Q+R}\right)$ where T, t, are the tensions, Q the quantity required, and R the resistance, and we certainly have the means of increasing or diminishing it to the extent of our ability to handle the generating electrical apparatus, up to the point of fusion of the conductor. By Ohm's principles, and also by the demonstrated experiments of Coulomb, when a surface charged to any given intensity is brought in contact with another surface the electricity is distributed between them and the tension falls in proportion to the combined surfaces divided by the first surface; the time to convey a given quantity of electricity into a given surface will depend therefore on the *extent* of the first charged surface and the tension of the charge, with the resistance to conduction. As the quantity of electricity flowing from S to s at any moment after contact will be $\frac{T-t}{R}$ and the time for passing the whole quantity or producing equilibrium $\left(\frac{T-t}{R}=0\right)$ will be dependent on the quantity to be passed, and as this latter is $\frac{S^2 T}{S+s}$, it is evident that the whole time for charge is dependent on the value for S as well as of s and the tension of the source; and that therefore the time in the problem of the conveyance of a given quantity of electricity from a charged surface S to a recipient surface s will be a decreasing function of S.

The Atlantic cable is a Leyden battery of over four acres of coated surface, (the surface of the conductor). The electrical arrangements for working the cable I cannot learn, but suppose they use an ordinary intensity battery of small pairs, probably having terminal plates of but a few square inches of surface: hence we have the ratio of S to s as millions almost; when this small charged surface contacts with the great one, its tension is lowered enormously, the difference of tensions is almost destroyed, consequently the quantity carried in a given time is proportionally diminished $\left(\frac{T-t}{R}=Q;\ \text{when } T-t=0 \text{ then } Q=0\right)$.

Is it any wonder under such circumstances that four or even ten seconds, as rumor states it, is required to convey into the cable the quantity of electricity required to raise the tension to the point due to the great number of elements in the voltaic generator they employ.

The electricians of the cable seem to have concluded that the tension of the terminals of the battery would continue after contact, although the demonstration of Ohm, and in fact all the analysts of the distribution, have shown that it would fall, and my experiment published in the report of 1855 has even made the decline visible to the senses; or they seem to have proceeded on the supposition that the battery would in all cases maintain a maximum intensity by generating the electricity faster than it could be carried: that is as though the terminals of the battery would maintain the tension exhibited in the open circuit. They appear to have been likewise regardless of the warning of Ohm, that in the case of the exterior conduction resistance being removed or greatly decreased, a certain additional resistance will arise from the mechanical obstruction of the chemical reagents and products, a resistance which must be determined not only for each electro-chemical arrangement but also for each mechanical construction and size. These are conditions however which do not generally affect the distribution, and sensibly affect the generation only when the battery is under circumstances for vigorous action; that such circumstances obtain when the contact is made with the four acres—circumstances which are almost equivalent to uniting the terminals of the battery with a short thick wire—is shown by Mr. Faraday's describing "a *rush* of electricity into the wire" at the moment of contact (see Phil. Mag. vol. vii, p. 199). In the general formula $\frac{nE}{R+r}=Q$ which is generally taken for the equation of the distribution, if we make $R+r=0$, Q becomes infinite: a condition which constitutes *detonation* and readily obtains to the amount of the matter present in the firing of certain mixed gases, guncotton, the fulminates and a few more substances, but which thank heaven is hindered from obtaining in the great majority of electrical actions (the multitudinous phenomena of nature) by the obstruction due to mechanical resistances. One consequence of the removal of the whole of the conduction resistance would be that when we touch a piece of oxydable metal, both the metal and finger should explode; happily the mechanical resistance prevents this, and even in the most energetic forms of the voltaic battery it is so great as to make the generation of very large quantities of electricity a matter of great difficulty.

To form an idea of the limiting power of this resistance I dusted pulverulent platinum over a plate of zinc of one square

foot of surface, and immersed it in a mixture of one part acid in five of water, and found that one pound of zinc was dissolved in fifteen minutes; this then was the measure of the maximum amount of electricity a battery of such size could generate in fifteen minutes; but the whole amount a practical construction of plates of such size could generate, would not be the tenth of that amount, and it is easily foreseen that whatever the amount might be, a cable of such length and favorable arrangements for "static induction" could be constructed that all the electricity which could be generated by a series of such pairs, in fifteen minutes, with least conduction resistance, could be disposed on its sides before it would constitute a charge, and consequently the charging of such cable with that battery would require more than fifteen minutes.

The whole quantity of electricity which any battery will generate in a given time under any given circumstances will be proportional to the size of the battery plates and the interior conduction resistance, and consequently the time required for any battery to charge the Atlantic cable will be in an inverse relation to the size of the plates—the number of pairs not affecting this: it merely determining the tension to which the charge rises; though on this latter depends the available quantity at the receiving end for recording.

A battery to charge the cable in the *least* time should have the plates of *unlimited* size: this would not be possible, neither would it be practical to have them bear any small proportion to the four acres to be charged. The minimum time however may be nearly obtained by using a sufficient reservoir to collect the electricity evolved from convenient sized plates and thus working the cable by means of an immense Leyden battery. For this purpose I would construct a Leyden jar of metallic sheets and varnished paper or silk, of several acres in extent, and connect the alternate metallic sheets with suitable bars for attaching the battery with the earth and cable. It will doubtless at once be perceived that it would take quite a time to charge such a Leyden jar—say eight acres—by the battery, and here it will be seen that the mask is up which has disguised the time of charge (the so-called *wave time*). To merely enlarge the battery plates somewhat above their present dimensions would doubtless obviate the difficulty to a proportional extent, but full enlargement should be made, for it will be desirable to work as rapidly as possible. With such a Leyden battery as I propose the tension which propels the electricity into the wire could at no time fall more than one third, and its effective power in charging the cable would be some thousand times greater than an arrangement of an intensity series of small pairs. In short, it is apparent that by such an immense Leyden arrangement and a sufficient battery

to charge it, the electricity would find its way through the conductor or through the insulation.

From the tone of the European publications I have been led to infer that they do not consider it possible to work the cable in a prompt and efficient manner by means of the battery. The slow and imperfect action of the Balaklava and some other cables seems to have early thrown a damper on the prospects for submarine lines, and the suspicion seems to have become conviction after the publication by Mr. Faraday of his experiments, together with those of M. Melloni and Mr. Clark; according to those experiments it is demonstrated that increasing the number of pairs in the battery, or increasing the "*intensity*," as this operation is often improperly called, does not diminish the "wave time" or the time for the electricity to flow through the conductor. By the experiments on the subterraneous wires of the Manchester telegraph, the time for the current to manifest itself through 762 miles of wire, was the same whether 30 pairs, 50 pairs, or any number of pairs up to 500 were used. If I do not mistake the tone of these, and all the subsequent papers on the wave time for submerged conductors, these experiments are regarded as decisive against the possibility of shortening the time by any modifications of the battery. At the results of those experiments M. Melloni appears to express astonishment, and considers it as opposed to the laws of Coulomb and others, and against the received ideas of *quantity* and *intensity*. Mr. Faraday appears to be disappointed however, he having predicted if I rightly apprehend his meaning, that the current from the greater number of pairs should have manifested itself more quickly than that from the lesser, and this nonconformity of the experiment with his predictions he attributes to the fact that while the *intensity* of the current was increased, its *quantity* was also increased, and considers with the increase in the number of the pairs, their *size* should have been diminished in order that only the same quantity of electricity in a more intense condition might have been permitted to traverse the conductor. From all this it is evident that those views offer but small prospect of the battery ever serving to work the submarine telegraphs. I cannot however, but express astonishment that any other effect on the wave time, from increasing the number of pairs, than that exhibited in the experiments of Mr. Clark should have been expected, considering that at the first moment of the contact of the battery with the insulated submerged conductor, the insulation in undergoing polarization is acting as a conductor; thus at the beginning of contact, the wire acts not only as a conductor of the capacity of its cross section, but also as though it had a solid section of the area of its whole surface, thus acting on the battery, as a short thick wire (in the case of the Atlantic cable

as a wire having a solid section of 185,000 sq. ft.) in which the resistance exterior to the battery may be considered as nothing, and the whole resistance to the generation of the electricity as being only that which lies within the battery: now taking Ohm's formula for the electric current $\frac{E}{R+r}$, in which E represents the electromotive force of the chemical affinity, R the resistance to conduction due to the materials of the battery, and r the resistance of the conductor which completes the circuit by connecting the poles of the battery, and considering the effect of multiplying the number of the elements we have $\frac{nE}{nR+r}$, and considering r as being indefinitely decreased by diminution of the length of the conductor, or by increase in its solid section, which are the conditions that obtain while the cable is receiving its static charge, we may consider it as $=0$, and remove it from the equation, and then we have $\frac{nE}{nR}=\frac{E}{R}$, in which it is evident a train of batteries in the conditions which obtain at the first moments of contact with the cable, can generate no more electricity than a single cell attached to the same conductor. It is here evident that the facts arrived at by Mr. Clark, so far from being a cause of wonderment, are but what the circumstances should have suggested, neither do they call for a modification of Coulomb's laws of induction, or a change of our ideas of quantity and intensity, as suggested by M. Melloni; much less do they indicate that a diminution of the size of the battery plates would hasten the current as suggested by Mr. Faraday. When a battery has the circuit open we conceive that the terminal plates have a tension proportional to the number of elements in the train, $T=nE$; and as the whole quantity of electricity they contain will be the product of their surface by the tension, $Q=TS$, it is evident that when the battery touches any inductive surface of great extent, such as that of the insulation of the cable, Q will be divided with it, and as S compared to that surface is insignificant, and as S is constant, T will fall enormously, as has been before shown for another purpose; now when the terminals of a compound battery, are connected with a stout wire, it is known that the tension falls to that of a single pair of plates, it is therefore evident that contact of the battery, with a large inductric surface, is equivalent to connecting with a non-resisting conductor. In this state of the battery it is evident that the electricity can be conveyed into the conductor only as fast as the battery can admit of the diffusion within, or bring the electricity to the terminals, in which case, as has before been shown, many pairs can generate no more electricity than a single pair, and consequently the tension will be below the maximum of a single pair,

in proportion to the smallness of the plates. Is it any wonder that with the feeble tension produced under such circumstances, such a long time is required for the battery to charge the cable?

For the sake of illustration I have considered $r=0$; such however is not strictly the case, the wire offers *some* resistance and the gutta percha offers some resistance to polarization, the tension of the terminal plates will therefore rise in proportion to this resistance until ultimately it reaches the maximum tension due to the number of electromotive èlements in the train. If we consider furthermore that with any finite resistance the tension will rise in proportion to the decrease in the value of R, or that the extreme tensions will be inversely proportional to the internal conduction resistance of the battery—or if in the formula $\frac{nE}{nR+r}=Q$ we give to r a small value and diminish R by enlarging the size of the battery plates, so as ultimately to obtain $\frac{nE}{\frac{nR+r}{m}}=m\,Q$—we see plainly that by enlarging the number of electromotive elements in the battery, and at the same time increasing their size, any required effect can be produced on the cable.

From all the above it is evident that the time for any battery to charge a Leyden jar will be in a certain inverse proportion to the size of the battery plates; the charging of the cable is similar to the charging of the jar, excepting that it is complicated by the resistance of the wire, and the time will be a function of the internal conduction resistance of the source of the electricity. The general mathematical considerations must apply to every electrical action, whether it be produced by thermo-electricity, by chemical action, by magneto-electricity, by induction coils, or by the lightnings from the clouds. But as the battery is the only effective source of electricity, and as it is the cheapest also, reason calls for the construction of a sufficient battery, for working the cable in preference to all secondary contrivances.

No one at all acquainted with the subject will doubt that such an immense Leyden jar as I proposed above for passing our longitude signals, if charged to a high intensity, would more than all other things be fitted for affecting the cable. If the great jar were not discharged in charging the cable, it would continue steadily to work it in the transmission of messages; a jar that would remain thus continually charged would be a *generator* of electricity; such is a galvanic battery, and by increasing the number and size of the plates, the battery is made into such a continuously charged jar capable of producing any extent of effect.

I have not considered the fact that by the resistance of the wire of the cable, and the reaction of the parts which first receive the static charge, the flow of the electricity is broken up into waves, and that consequently the *whole* of the insulation of the cable does not perform its full inductive office at once. I have necessarily been confined to general principles and admitted conditions of electrical action, the deductions however are the same as though the whole inductive surface of the cable were simultaneously charged, for the degree of charge given to the first portion determines the rapidity with which the successive portions receive their charge.

The plan I propose for large plates or an electrical reservoir has advantages also for the *discharge.* Already it has been proposed and is practised I believe to discharge the conductor by making contact with the opposite end of the battery. As the plan I propose offers such greatly increased electrical conditions, it will correspondingly decrease the time of discharge.

I have no doubt that you will at once coincide with me in the correctness of the views of the cause of the slow working of the cable. I think you have previously perceived that a great fall in the tension must take place at the moment of contact, and the consequent importance of having large terminal surfaces to hold a sufficient quantity of electricity to maintain the tension. The expression by you of such views I take it is what Dr. Gould refers to in his report on the telegraphic operations for longitude.

I have already extended this letter to a greater length than consideration for your valuable time would justify; but that I may succeed in presenting the correctness of my views on this important matter of the Atlantic telegraph let me trespass on you for a minute longer, to show that these new views are in fact *old*, that all electricians acknowledge them in their writings, and that the phenomenon of the delay of the current is amongst the earliest experiments in electricity.

When the knob of a DeLuc's column is brought into contact with a gold leaf electroscope, the leaves diverge. If while the leaves are diverged the terminals of the pile are brought in contact, one with the inner and one with the outer coating of a Leyden jar, the leaves collapse, and the jar is found feebly charged; if the pile is now detached from the jar the leaves will begin gradually to diverge again; if however the pile is left in connection with the jar the leaves will after some time (several minutes) diverge again. Now the time between the collapse of the leaves and their regaining their divergence, is the time required for charging the jar, to the tension due the pile:—that is, it is the time required for that generator of electricity (the DeLuc's pile) to generate the quantity of electricity required to charge that jar to the tension due to the pile. Not a single

electrician I suppose could be found, who would question the correctness of this; all will admit that the time is dependent on the ability of the pile to generate the electricity, and the extent of the inductric surface (the size of the jar). But is not this phenomena precisely equivalent to the charging of the cable? is the DeLuc's column a poorer generator in proportion to the surface of the jar than an ordinary battery is in proportion to the four acres of cable surface? Every electrician who would have the problem of diminishing the time of charging the jar by the column, would have to resort to methods of increasing the activity of the pile, either by changing the nature of its elements, or increasing their surface; then why does not the same doctrine hold good in regard to charging that big jar, the Atlantic cable?

I have endeavored to demonstrate that submerged telegraph lines differ from the land lines in requiring batteries having the plates *very large*, because the electrical condition of the cable at the first moments of contact are such that require a battery capable of furnishing a current of great *quantity* as well as great intensity. I have, however, made no indication of the precise size or number of plates which should be used for working the Atlantic cable, or any other submerged conductor, with greatest speed. The limit to the rapidity of working must be determined by the conditions for carrying off the heat generated in the conduction by the passage of the electric current; and as the quantity of electricity which may be used on any cable without endangering the gutta percha insulation by the heat of the conductor can be ascertained only by experiment, it is by this means only, that the best size and number of plates can be determined for working with the greatest speed the cable will admit of.

In the passage of very large quantities of electricity into the cable the heating effect on the portion nearer to the battery will be considerable, for although the measure of the heating power of the current is the conduction resistance, and the resistance of the current is destroyed by the induction "*masking*" the electricity; yet as the portions of the cable nearer to the battery are first charged, and the conductor, after the dielectric is charged, resists as an ordinary conductor, it is evident that those portions will be heated by the current; yet the whole quantity of heat produced will be less than if no inductive action took place. Considering the whole quantity of heat generated by the oxydation of a given quantity of zinc, or the resistance to the electricity thereby generated, which is the same thing, and the greatness of the surface to carry off that heat, it is easy to foresee that a very large quantity* of electricity might be used on the

* While a quantity of electricity even *insufficient* to charge the whole cable might *rupture* it if in a state of very great tension, yet no danger of this need be apprehended from *any quantity* of electricity obtained from any easily attainable number of voltaic elements.

cable without endangering it, and consequently a high speed in transmission obtained. For a first trial on the Atlantic cable I would use a Smee battery of about 500 pairs of plates, each having 20 square feet of surface; yet it may be found on trial that plates of much larger size may be required.

Although the present cable may be incapable of working with a satisfactory degree of certainty and rapidity, even with the best electrical management, yet this would not demonstrate that there cannot be a satisfactory electrical communication across the Atlantic. Certainly I will be justified in saying that the present state of the engineering art and the experience already obtained in laying submarine conductors, can lay down a new cable capable of transmitting 100 letters per minute, if it is constructed and worked in full regard to the principles of electricity.

ART. XVIII.—*On the Variation of the Magnetic Needle at Hudson, Ohio;* by ELIAS LOOMIS, Professor of Mathematics and Natural Philosophy in the University of the City of New York.

DURING my residence at Hudson, Ohio, between the years 1837 and 1844, I made repeated observations for the purpose of determining the variation of the magnetic needle. During the summer of 1849, while employed in determining the longitude of Hudson by telegraphic comparisons with Philadelphia, I repeated my observations for the variation; and Prof. C. A. Young, of Western Reserve College, has put into my hands a very complete series of observations made by himself during the past summer. All these observations were made with a variation compass by Gambey of Paris, having a needle about 18 inches long, supported by fibres of untwisted silk, and resting in a stirrup which admits of easy reversal. It is now proposed to compare these observations for the purpose of determining the annual change of the variation. As these observations were made at different hours of the day, it is necessary to apply a correction to reduce each result to the mean variation of the month of observation. As the observations required for this purpose have never been made at Hudson, or at any place in its immediate vicinity, we must rely upon observations made at a considerable distance. The nearest station at which such observations have been made is Toronto, which is north of the parallel of Hudson. On the southern side we have observations both at Philadelphia and Washington. I have preferred the latter, since Washington is nearer to Hudson than Philadelphia; and the parallel of Hudson is exactly midway between the latitudes of Toronto and Washington.

The following table shows for six months of the year, the quantity by which the variation at the hour named in column first, differs from the mean variation for the month at Toronto. The table is derived from five years observations between 1843 and 1848, and is copied from page 90, vol. iii, of the Toronto observations.

Diurnal change of the Magnetic Variation at Toronto.

Hour.	April.	May.	June.	July.	August.	Sept.
8 A. M.	4′96 E.	5′82 E.	6′20 E.	6′26 E.	6′90 E.	4′80 E.
9 "	3·96 E.	4·18 E.	4·72 E.	4·86 E.	4·76 E.	3·00 E.
10 "	1·30 E.	0·64 E.	1·73 E.	1·78 E.	0·54 E.	0·56 E.
11 "	2·02 W.	3·06 W.	2·00 W.	1·76 W.	3·12 W.	3·70 W.
noon.	4·54 W.	5·24 W.	4·72 W.	4·24 W.	6·00 W.	6·26 W.
1 P. M.	5·98 W.	6·28 W.	6·20 W.	5·86 W.	7·22 W.	6·38 W.
2 "	5·84 W.	6·10 W.	6·26 W.	5·96 W.	6·52 W.	5·40 W.
3 "	4·98 W.	4·84 W.	5·26 W.	5·12 W.	5·04 W.	3·36 W.
4 "	3·30 W.	3·12 W.	3·76 W.	3·68 W.	2·74 W.	1·16 W.
5 "	1·66 W.	1·26 W.	1·68 W.	1·86 W.	1·02 W.	0·42 W.
6 "	0·80 W.	0·44 W.	0·62 W.	0·70 W.	0·18 W.	0·12 E.
7 "	0·32 W.	0·22 W.	0·28 W.	0·36 W.	0·13 W.	0·06 W.
8 "	0·44 E.	0·18 W.	0·32 W.	0·66 W.	0·10 W.	0·24 E.

The following table shows for the same months the quantity by which the variation at the hour named in column first, differs from the mean variation for the month at Washington. It is derived from two years observations from 1840 to 1842, and is deduced from the table on page 326 of Gilliss' Magnetical Observations.

Diurnal change of the Magnetic Variation at Washington.

Hour.	April.	May.	June.	July.	August.	Sept.
h m						
0 12 A. M.	0′97 E.	0′65 E.	0′67 E.	0′96 E.	0′82 E.	0′58 E.
2 12 "	1·81 E.	0·93 E.	0·39 E.	1·16 E.	0·99 E.	1·02 E.
4 12 "	2·42 E.	1·33 E.	1·27 E.	1·57 E.	1·26 E.	1·47 E.
6 12 "	2·75 E.	3·65 E.	4·09 E.	3·58 E.	4·03 E.	3·05 E.
8 12 "	3·21 E.	3·97 E.	4·72 E.	4·56 E.	5·30 E.	3·91 E.
10 12 "	1·04 E.	0·28 W.	0·19 E.	0·94 E.	0·59 W.	0·37 W.
0 12 P. M.	3·37 W.	3·80 W.	3·83 W.	3·86 W.	5·63 W.	4·84 W.
2 12 "	5·12 W.	4·60 W.	4·80 W.	5·31 W.	5·51 W.	4·52 W.
4 12 "	3·26 W.	2·45 W.	3·36 W.	3·41 W.	2·65 W.	1·51 W.
6 12 "	1·69 W.	0·48 W.	0·62 W.	1·19 W.	0·70 W.	0·54 W.
8 12 "	0·01 W.	0·64 E.	0·80 E.	1·01 W.	1·27 E.	1·22 E.
10 12 "	1·25 E.	0·45 E.	0·48 E.	1·03 E.	1·75 E.	0·54 E.

The following table shows the observations of the magnetic variation at Hudson. Column first shows the day of the month and year; column second the hour of observation; column third the observed variation; column fourth the correction applied to reduce the observation to the mean for the month; and column fifth shows the variation thus corrected. The correction is obtained by taking the mean of the numbers furnished by the Washington and Toronto observations.

Observations of the Magnetic Variation at Hudson.

Date.	Hour.	Variation observed.	Correction.	Variation corrected.
	h m	′	′	′
1839 April 15.	3 30 P. M.	51·96 E.	+4·02	55·98 E.
1840 April 13.	9 40 A. M.	53·87	−1·88	51·99
1841 May 18.	6 51 P. M.	48·80	+0·18	48·98
1842 May 12.	2 43 P. M	49·23	+4·60	53·83
" Sept. 20.	10 57 A. M.	43·35	+2·76	46·11
1843 June 17.	4 23 P. M.	38·87	+3·04	41·91
" Sept. 19.	8 2 A. M.	47·65	−4·29	43·36
1844 June 8.	4 1 P. M.	38·20	+3·61	41·81
1849 July 24.	5 14 P. M.	30·04	+1·93	31·97
1858 July 22.	11 40 A. M.	9·37	+3·03	12·40
" July 26.	6 12 P. M.	11·47	+0·91	12·38
" July 28.	4 1 P. M.	5·61	+3·59	9·20
" Aug. 4.	0 6 P. M.	9·30	+5·73	15·03
" Aug. 9.	6 10 P. M.	10·58	+0·43	11·01
" Aug. 16.	11 37 A. M.	4·25	+4·52	8·77
" Aug. 17.	5 55 P. M.	9·50	+0 61	10·11
" Sept. 1.	2 32 P. M.	9·52	+4·04	13·56

In order to deduce from these observations the most probable result, let us put δ for the mean variation Jan. 1, 1839, and Δ for the annual motion. Then if we regard the observations of any one year as forming a single observation, we shall have the following eight equations of condition.

$$\delta + 0{\cdot}285\,\Delta = 55'{\cdot}98 \qquad \delta + 4{\cdot}586\,\Delta = 42'{\cdot}63$$
$$\delta + 1{\cdot}279\,\Delta = 51{\cdot}99 \qquad \delta + 5{\cdot}433\,\Delta = 41{\cdot}81$$
$$\delta + 2{\cdot}375\,\Delta = 48{\cdot}98 \qquad \delta + 10{\cdot}558\,\Delta = 31{\cdot}97$$
$$\delta + 3{\cdot}538\,\Delta = 49{\cdot}97 \qquad \delta + 19{\cdot}598\,\Delta = 11{\cdot}56$$

Solving these equations by the method of least squares, we obtain $\delta = 55'{\cdot}213$, which is the mean value of the variation for Jan. 1, 1839; and $\Delta = -2'{\cdot}2416$; that is, the easterly variation is diminishing at the rate of $2\frac{1}{4}$ minutes in a year. We also conclude that the line of no variation will pass through Hudson sometime during the year 1863.

Art. XIX.—*On the Dynamics of Ocean Currents;* by Lieut. E. B. Hunt, Corps of Engineers, U. S. A.

(Read before the American Association, at the Baltimore Meeting, May, 1857.)

It can scarcely be denied that the state of our knowledge of ocean currents is any thing but satisfactory. Not only are we to a very great extent ignorant of the precise state of the facts, but we are also deficient in the theoretical exposition of those already known. We can easily explain our lack of precise knowledge of facts by reference to the circumstances. The vast oceanic areas can be observed only by persons engaged in navigation, who are mostly unfurnished with proper means for correct determinations, and who lack that special training which is a prime

essential for good observations. The facts to be observed are also of a character so complex and elusive, are so subject to fluctuation in a given locality, and are involved in movements of air and water of so vast compass, that we cannot hope for precision of knowledge by the use of means now in operation. The single fact that most observations are made on the water surface while the ocean depths are of vital efficacy in shaping all marine phenomena, gives a character of signal incompleteness to those observations which have been mainly instrumental in fixing the received notions on the system of oceanic circulation. It is a fit subject of regret that the discussion of ocean movements has been so rarely attempted by those whose previous training in mathematical or mechanical science would have been a sufficient guaranty and preventive against the wild and illogical rhapsodies of theorists who have run riot over the broad domain of the physics of the sea.

With a view to apprehending the mechanical elements of this problem of ocean currents, let us first suppose a terrestrial sphere, which has assumed the equilibrium condition, resulting from gravitation, diurnal rotation, a solid nucleus and a homogeneous water envelope unbroken by land. This water stratum would shape itself so that its bounding surface would be a strictly mathematical level surface. A level surface of this nature may be defined as one which is at each point perpendicular to the resultant of all the forces acting on the individual molecules situated in that surface. In this case it would be a continuous oblate spheroid to which the resultant of gravity and centrifugal force would be everywhere normal. If to this we add those diurnal disturbances of the normal level due to the irregularities of solar and lunar attraction during the earth's rotation, we obtain the tidal waves which appear as perturbations of the normal level. If the continental masses be supposed to be elevated, we have a slightly modified normal level surface for the ocean; but one, which once determined becomes the proper standard of reference for all oceanic perturbations, to whatever cause due. This surface is everywhere the true bounding surface, and cuts the resultant of gravity and centrifugal action for the earth *as it is*, perpendicularly at each point of the surface, and is entirely continuous, though no more truly spheroidal. This is the normal ocean level, and it is a useful surface of reference for all vertical ocean movements or perturbations. If we now suppose the homogeneous earth without continents subjected to the heating action of the sun's rays, the result will be that the equator will become a line of maximum heating, from which to the poles there will be a progressive diminution of heat absorption. This would cause an expansion of the heated waters which would thus rise above the normal level surface by an amount equal to

the expansion at each point. Thus from the pole to the equator a spheroidal meniscus would be spread equal to the ocean expansion under the solar heat. It is a remarkable feature that the heating leaves each vertical ocean column of its original weight, and there is thus a perfect mechanical equilibrium between these columns considered as joined by their interior bases. Thus considering the grand ocean masses, there is no disturbance of static stability from the heating agency of the sun, hence there is no formation of massive currents due to this cause.

If now we regard the heated ocean in its hydrodynamic aspect, we find that the bounding surface having everywhere a slope toward the pole exceeding that of the normal level surface, there remains an unresisted surface tendency towards the pole which primarily tends to produce a superficial flow from the equator polewards. This gives manifestly but a slight disturbance of normal level, amounting in the meridian quadrant only to the vertical expansion at the equator, and being diffused over the entire quadrant. It is extremely doubtful if this would suffice to overcome the passive resistances and produce an actual surface overflow. If, however, a current were once established by any other agency, such as the wind, the equatorial heating would constantly operate to maintain this current. The heated waters would constantly be lifted as a floating mass on the colder waters which, pushing on the lighter equatorial mass at its base, would come in to replace any deficiency of mass due to the superficial outflow. Taking the facts as they are, we find in the trade-winds and the resistance of the continents, two causes fully adequate to break up the static equilibrium referred to, and obviously giving the precise direction to the outflow which it actually has. Thus while the type of action induced by the solar heating power considered along the meridian is surface outflow and deep inflow, the perennial trades determine this circulation along a different and constant route, fixed first by continental obstructions, and essentially modified in direction by the earth's rotation.

As the equatorial evaporation greatly exceeds the corresponding rain fall, this operates to counteract in part the regular outflow by diminishing the quantity of water to be discharged on account of expansion due to heating. This would also increase the saltness and specific gravity of the equatorial waters, and to that extent would bring their actual surface into close accordance with the normal level. It is clear that this saltness could not fully compensate for the expansion by heating, or we should have the surface reduced to the normal level, when all would either be in stable equilibrium, or below it when the currents would be reversed.

It thus appears that the expansion due to equatorial heats induces a superficial derangement tending to an outflow towards

the poles, which by the trade winds and continents is determined along a single line of *debouche.* This gives a discharge with far less frictional resistance than a direct meridional outflow would encounter, as this would involve a polar set for the entire ocean surface.

Accepting the well-determined trade-winds and the equatorial current as certain facts, we shall find that the vast surface sheet of water which has a westerly set under the trades, having acquired a very considerable velocity, becomes the representative of a vast amount of living force. When by impact against western barriers this vast sheet of water undergoes inflection to the north or south, it still retains the greater portion of its living force, and will continue to do so until this is wholly expended in overcoming resistances. If now we bear in mind that the wide equatorial sheet is by this deflection consolidated into a compact current of deep section, and also that the resistance per mile is proportionate to the length of the line of frictional resistance in a cross section, we shall see that the currents turn towards the poles with their forward impulse almost unabated, and with the resistances greatly reduced. We ought, therefore, to expect that the inertia of this vast moving mass would suffice to carry it on with a mean velocity, slowly abating, to the polar regions. So soon as the progress of the current gives it an increasing latitude, the effect of the diminishing parallels in giving an eastward trend would show itself; and, combined with the forward projectile motion of the mass of waters, would determine the route of the current, governed, of course, by solid opposing masses of continents, islands, and shoals.

Reaching the artic neighborhood, this current would fall in with the tendency to restore to the equatorial region the waters withdrawn by outflow, which thus leave a deficiency of static mass in that region. Its forward force not yet expended, would bring it into the equatorial flow only after a long arctic sweep. Then bordered in by the eastern occean coasts, it circles on to the equatorial belt, there to start the repetition of its course either directly, or by proxy, if, entering at great depths, it serve only to lift higher portions above the normal level. We have thus a continuous circuit in which the water whirls under the primary impulse derived in the equatorial regions, an outflow due to heating and the direct propulsion of the trade-winds. The primary order of circulation is in two currents, the upper running polewards, and the under from the poles to the equator. This order is entirely modified by the action of the trades, and becomes essentially a horizontal circulation, the propelling action of these perennial winds, conspiring with the outflowing declivity to determine an immense movement, of which the living force imparted in the equatorial region suffices to carry on the circuit in full and enduring activity.

This consideration of the effect of inertia in storing the living force of this immense equatorial current, and thus enabling it to sweep through the cycles of the seas, has not been duly considered. These currents, in such a place as Florida Straits, move in a closed channel, and are subject to the hydrodynamic rules for this case. The gradual changes of direction and velocity there imposed, produce less absolute resistance than is generally imagined, by reason of the great mass of waters relative to the area of frictional surfaces.

The problem of ocean currents is of very great complexity, not only on account of the difficult hydrodynamic questions involved, but because the effect of the winds on the ocean surface can scarcely be subjected to estimation. The permanent elevation of the equatorial waters above the normal level traced from the pole, might be approximately determined by knowing the mean equatorial ocean temperature at all depths, and the same from point to point towards the poles, accompanied with observations on the corresponding saltness. Were there a considerable deficiency of weight in the vertical equatorial column, relative to an arctic one, connected by their bases at the same deep level, this would at once generate a corresponding wave towards the equator. As we may be sure that the equatorial mean ocean temperature exceeds the artic mean temperature, we must concede *some* elevation above the true normal level throughout all the warmer latitudes, but any attempt to definitely fix its amount, would be very rash in the present state of our knowledge.

There are numerous secondary points which might enter this discussion, but which need not now be considered. I will notice a slight oceanic oscillation which is practically unimportant; but which I believe has not before been noticed. The sun in its daily round must heat the waters of the sea, at a given locality, in such a manner that there shall be a daily maximum and minimum sea temperature due to absorption and radiation combined. This must give a maximum and minimum of expansion, or a species of tidal wave would follow the sun, which might well be called the heliothermal tide. It would clearly be too minute for separate observation, and though curious, cannot be important.

Another circumstance is worth notice here. A forward current in the sea has a distinct bounding surface on which it encounters a frictional resistance. The mode in which this resistance is expended is by a constant dragging into the forward movement parts of the layer of water making the boundary of the current. Thus if a current be moving through a sea otherwise tranquil, it will by this lateral dragging carry forward such a volume of water in addition to its own proper mass, that a counter-current must set in to restore the level. This is, I sup-

pose, the explanation of some of the counter currents which exist along the great oceanic currents, as also of the eddy currents of rivers. These too imperfect generalizations may do something towards making the system of ocean currents more comprehensible. So great a subject needs treatment far different from what it has yet received, and first of all the essential facts should be more clearly established. Unfortunately this can result only from long, well organized, and costly operations for this express purpose. We must be content to do our several small parts patiently, hoping for more light in the future.

ART. XX.—*Report on Dupont's Artesian Well at Louisville, Ky.*; by J. LAWRENCE SMITH, M.D., Prof. Chem. University of Louisville.

THIS work was commenced in April, 1857, from the bottom of a well that had a depth of 20 feet, the boring tools employed made a hole 5 inches in diameter to the depth of 76 feet from the surface; the boring was now reduced to 3 inches, and thus continued to the bottom of the well. The depth of well is 2086 feet; flow of water 330,000 gallons in 24 hours; rise above the surface 170 feet.

The rock struck, which geologically belongs to the Devonian series, is for 38 feet shell limestone; then for 40 feet coralline limestone; at which depth the Upper Silurian is reached. Without being able to make out with any degree of certainty, the amount of Upper Silurian passed through, we suppose it to be over 1200 feet. At the depth of 1600 feet a sandstone was reached, doubtless of the Lower Silurian, and 97 feet deeper was encountered the first stream of water which reached the surface. This flowed out abundantly and with much force. The quantity not being sufficient, the boring was continued. After this, it was unnecessary to use the bucket to take out the material detached by the borer, the force of the water bringing up the fragments very readily. The water increased in quantity in going deeper, the increase being more marked at 1879 feet, and still more at 1900 feet, where pieces of rock weighing an ounce or two came up with the water. The water increased every ten or twenty feet to the depth of 2036 feet; here a very hard magnesian limestone was encountered 6 feet in thickness. After which the sandstone reappeared, and for the next 50 feet there was no increase of water.

The following table exhibits the series of rock as far as it is possible to make it out by the fine fragments taken out at different depths, beginning at the top:

76 feet, sand and gravel.
100 feet, tolerably pure limestone, with fragments of fossils.
12 feet, soft limestone mixed with clay.
52 feet, tolerably pure limestone mixed with fossils.
5 feet, limestone with ferruginous clay.
81 feet, gray limestone.
157 feet, limestone mixed with clay.
149 feet, tolerably pure limestone with many portions quite white.
13 feet, clay shale with little calcareous matter.
207 feet, limestone with a little blue clay shale.
33 feet, same, little darker and more shale.
Next 94 feet, pure, very white limestone with fossil alternating with very dark limestone, color probably from organic matter, with some dark shale.
26 feet, shaly limestone.
40 feet, very light and hard pure limestone.
1 foot, white clay.
546 feet, gray limestone, alternating hard and soft.
41 feet, sand rock—white.
4 feet, same, very fine and hard, with little limestone.
60 feet, same, with more lime.
72 feet, same, less limestone.
308 feet, same sandstone with but little lime.
6 feet, magnesian limestone, very hard.
50 feet, sandstone again.

At the urgent request of many citizens of Louisville, the boring was now stopped to give a fair test of the medical virtues of the water that was pouring forth at the rate of 230 gallons per minute, or about 330,000 gallons in 24 hours. The water, by its own pressure, rises in pipes 170 feet above the surface.

The boring was accomplished in sixteen months, and the depth reached is 2,086 feet. In order to conduct the water to the surface and prevent its passing off into the gravel beds below, a tube five inches in diameter leads from the surface to the rock, a depth of seventy-six feet, into which it is driven with a collar of vulcanized gum elastic around it. No tubing is found necessary for any other part of the boring.

When the size of the bore (three inches in diameter) and its depth are considered, the flow of water from the well is unequalled by any other artesian well yet constructed that flows above the surface, for, although the Grenelle well at Paris delivers 600,000 gallons in twenty-four hours, it has at the bottom an area six times as great as the Dupont well, and a few hundred feet up seven times as great. A corresponding diameter to Dupont's well would, according to just and reasonable calculations, furnish about 2,000,000 gallons in twenty-four hours; also the elevation of the water above the surface is greater than that of any other artesian well, and it is only exceeded in depth by the St. Louis well, and that to an extent of 113 feet.

The water comes out with considerable force from the five-inch opening, and a heavy body thrown into the mouth of the well is rejected almost as readily as a piece of pine wood. By an approximate calculation, its mechanical force is equal to that of a steam engine with cylinder 10 by 18 inches, under 50 lbs. pressure, with a speed of 55 revolutions per minnte, a force rated at about 10 horse power. The top of the well is now closed, and the water conducted about 30 feet to a basin with a large jet d'eau on the centre, from which there is a central jet of water 40 feet in height, with a large water pipe, from which the water passes in the form of a sheaf. When the whole force of water is allowed to expend itself on the central jet, it is projected to the height of from 90 to 100 feet, settling down to a steady flow of a stream 60 feet high.

Temperature of the Water.—The water, as it flows from the top of the well has a constant temperature of 76½° F., and is not affected either by the heat of summer or the cold of winter. The temperature at the bottom of the well is several degrees higher than this, as ascertained by sinking a Walferdin's registering thermometer to the bottom, which indicated 82½° F. Taking as correct data that the point of constant temperature below the surface of Louisville is the same as at Paris, namely, 53° F., at 90 feet below the surface, we have an increase of 1° of temperature for every 67 feet below that point. The increase in Paris is 1° for every $61\frac{2}{10}$th feet. The temperature of the water is sufficient for comfortable bathing during most of the year, a circumstance that will be of considerable importance, if it ever be turned to the use of baths. The reason of the difference of 6° between the water at the bottom of the well and at the top is, that the iron pipe leading from the surface to the rock passes through a stratum of water 60 feet thick, having a temperature of 57°.

The Source of the Water.—The question naturally arises, if the vein of water supplying this well has a connection with some distant source higher than the surface of Louisville, where is that source? From all that we have been able to learn of the geology of this county, taking Louisville as a center, the first rocks encountered corresponding to the sandstone (in which the water of the artesian well was struck) are in Mercer, Jessamine, and Garrard counties, near Dix Creek, to the east of Harrodsburg. The rocks there are said to be cavernous and water-bearing. The elevation is about 500 feet greater than Louisville, and about 75 miles in a straight line from this city.

This being the most probable source of the water, from whence come its mineral constituents? These are obtained from the rocks through which it percolates in its way from its source to the point below Louisville, where it has been tapped, and where

it will doubtless flow in undiminished quantity for centuries to come, as wells having such deep sources as this, are usually inexhaustible.

Nature of the Water.—The water is perfectly limpid, with a temperature as already stated of $76\frac{1}{2}$°, which will be invariable all the year round.

Its specific gravity is 1·0113. The solid contents left on evaporating one *wine gallon* to dryness are $915\frac{1}{2}$ grains, furnishing on analysis:

	Grains.
Chlorid of Sodium, (common salt,)	621·5204
" Calcium,	65·7287
" Magnesium,	14·7757
" Potassium,	4·2216
" Aluminum,	1·2119
" Lithium,	0·1012
Sulphate of Soda,	72·2957
" Lime,	29·4342
" Magnesia,	77·3382
" Alumina,	1·8012
" Potash,	3·2248
Bicarbonate of Soda,	2·7264
" Lime,	5·9915
" Magnesia,	2·7558
" Iron,	0·3518
Phosphate of Soda,	1·5415
Iodid of Magnesium,	0·3547
Bromid of Magnesium,	0·4659
Silica,	0·8857
Organic Matter,	0·7082
Loss in analysis,	8·1231
	915·4582

GASES IN ONE GALLON.

Sulphuretted Hydrogen,	2·0050
Carbonic Acid,	6·1720
Nitrogen,	1·3580

The analysis was performed by the usual methods; but as chlorid of lithium was sought for and found, it may be of interest to detail the method of research in this particular, as a guide to similar investigations of other mineral waters in this country. Ten gallons of water were evaporated to about two pints, (there was an abundant deposition of salts,) to this was added one gallon of 95 per ct. alcohol; it was then thrown on a filter, and the salts on the filter washed with alcohol of the same strength—the filtered liquid was evaporated nearly to dryness; in the present instance the residue consisted of a few ounces of a thick syrupy liquid; to this was added one pint of absolute alcohol, addi-

tional salts were precipitated; the liquid was again filtered and evaporated nearly to dryness—to it were added 8 oz. distilled water and two ounces of milk of lime, (pure lime made by igniting carbonate of lime prepared by carbonate of ammonia,) the lime was added for the purpose of precipitating the magnesia and alumina—again filtered and washed; the filtered liquid was somewhat concentrated, and while warm, carbonate of ammonia added to precipitate the lime; it was then filtered and evaporated to about a fluid ounce and treated with a little lime water and carbonate of ammonia alternately, to insure the absence of the last traces of magnesia and lime.

Before going further, it would be well to state that the treatment of alcohol separates the great mass of salts that are held in solution by the water, and which interfere with the detection of so minute a constituent as the lithium salt—by the alcohol we reduce the salts to small amounts of chlorids of magnesium, aluminum, calcium, sodium, potassium and lithium; by the lime the first two are got rid of, and by the carbonate of ammonia the lime is precipitated.

The solution, now containing the chlorids of sodium, potassium, lithium and ammonium, is evaporated to dryness, and the residue heated to dull redness, by which the ammonia salt is expelled and a little organic matter destroyed; the residue is next dissolved in water, and a drop or two of the liquid tested for a sulphate; should this be present it must be got rid of by exact neutralization with chlorid of barium, (a slight excess of the chlorid of barium will not interfere with the other steps in the analysis); in the examination of the water in question no trace of sulphate was found at this stage of the process, so it was again evaporated to dryness in a small capsule over a water bath; there were now a few grains of residual matter. To this was added an ounce of a mixture of equal parts of pure ether and absolute alcohol, the capsule was covered with a small receiver and allowed to stand for 18 hours; the liquid was then thrown on a small filter, and the filter washed with a little of the mixture of ether and alcohol. The alcoholic ether solution evaporated to dryness furnished the chlorid of lithium recognized by its well known characteristics. Although this process requires considerable time and some careful manipulation, its results are both accurate and satisfactory.

The water of this artesian well has very valuable medical properties, and those readers who are curious to examine into these points, will obtain all the required information by sending to Louisville for the medical report.

ART. XXI.—*On Modes of increasing the Heat of the Mouth Blowpipe, and some new Blowpipe Manipulations;* by Prof. HENRY WURTZ, of the National Medical College, Washington, D. C.

[Read, with experimental illustrations, before the American Association for the Advancement of Science, at Baltimore, April, 1858.]

IN the course of some blowpipe investigations which I have in progress, it has been found extremely difficult, and sometimes impossible, to obtain in the ordinary way sufficient heat for the production of certain desired effects. Attempts were therefore made to devise means of increasing the heating power of the instrument, and this object has been so far attained, and by means so simple and efficient, that I take this opportunity to make these means public, that others may also be benefitted thereby. To blowpipe analysts it is not necessary for me to detail the advantages to be gained in many cases by a practicable mode of increasing the heat, of which advantages not the least important is the saving of time.

It was first observed that in the ordinary mode of manipulation, a great part of the heat was conducted away from the bead by the cold part of the platinum wire contiguous to it. This is easily prevented by simply bending the wire previously, at right angles about an inch or an inch and a half from the loop that is to hold the bead.* On then holding the bead at the point of the blue cone of the flame, and the wire so that the bent portion is coincident with a continuation of the axial line of the flame, this bent portion becomes also heated to high redness, losing thus in a great degree its tendency to abstract heat from the bead. By this little contrivance alone the heat is increased to so important a degree, that I venture to think that no one who has once tried it, will ever use a wire of any other form.

I next directed my attention to the *combustible* used. An ordinary alcohol flame, as every one knows, gives with the blowpipe a comparatively feeble heat. A gas flame is much superior, and a large *wax candle* gives probably a higher heat than any thing else at present commonly in use among blowpipe operators. It occurred to me that the heating effect was probably proportional to the *density* of the burning vapor, or the quantity of

* At the time the above was read, I had no suspicion that the contrivance of bending the wire had ever been published before, or thought of, by any other than myself. Since, however, Prof. Brush of New Haven has directed my attention to a passage in the last edition (1853) of Plattner's "Probirkunst mit dem Löthrohre," page 14, where the same device is identically described, as used for fusing platinum wire. I desire, therefore, stating at the same time that I have been in the habit of using it for more than ten years, to disavow all claim to priority, hoping still that some novelty may be found in my modes of making use of the invention.—H. W.

combustible matter contained in the same volume. I therefore searched for combustibles having a high density of vapor, and found that the *paraffine* of Reichenbach, now known from the investigations of Hofstaedter* and Filipuzzi† to be a mixture of different isomeric hydrocarbons, all of which must have very high equivalents, was found by Lewy‡ to have a vapor-density of not less than 11·8. By inquiry, I found that candles composed of this, or a similar material, obtained from the products of distillation of the well-known "Breckenridge Coal," could be bought in New York. On procuring some of these, and using them as *pabulum* for the blowpipe-jet, I found my anticipations fully realized. The flame obtained by means of the paraffine candle is much hotter than that from a wax candle. Unfortunately the candles made in New York are small, and have *extremely* small wicks, which renders them difficult to manipulate with, because the least motion of the jet-piece, by throwing it out of the centre of the flame, deranges the form of the cone. This can of course be easily remedied by having larger candles made with larger wicks.

Next, and lastly, *the blowpipe itself* seemed to me susceptible of improvement, by the introduction of an agent to absorb the moisture and carbonic acid of the breath, which must necessarily diminish the heating power of the flame. I have therefore sought to eliminate these obstacles by using, instead of the tube of the ordinary blowpipe, a somewhat larger tube filled with fragments of caustic potash. In the instrument which I have heretofore used, and which I now exhibit, this tube is composed of glass, and is united with the jet-piece of an ordinary blowpipe of Berzelius' form by means of a perforated cork; but of course in practice this tube may as well be composed of metal to avoid breakage. I use the ordinary *potassa fusa*, occurring in the shops in the form of sticks, broken up to about the size of a split pea, the fragments being confined in the tube by a plug of cotton at each end. It is advisable, when this kind of blowpipe is not in use, to keep the upper end of the tube corked. It remains yet to be seen whether the additional advantage gained by using a blowpipe of this construction will compensate for the concomitant inconveniences, though the latter are far less important, according to my own experience, than many would suppose.

Now as to the effects which may be produced by the combination of these several appliances. Platinum wire of medium blowpipe size is fused with little difficulty, and I have obtained beads of considerable diameter. Fine platinum wire melts down

* Liebig and Kopp's Jahresbericht, 1854, 608.
† Ibid. 1855, 630.
‡ Loewig's Chemie der organischen Verbindungen, ii. 564.

like wax. A borax bead volatilizes rapidly in white smoke. By moistening the end of a bent platinum wire, and dipping it into pure carbonate of lime or pure magnesia, and exposing it to the flame, a very fair exhibition of Hare's lime light, in miniature, may be made. The fusion of a small iron wire, and the combustion with brilliant scintillations of a small steel watch spring may be exhibited as class experiments in a very striking manner.

Berzelius, in his work on the Blowpipe,* says, "I am convinced that the temperature produced by the blowpipe, fed by air from the lungs, has a distinctly defined limit; so that, for instance, *alumina* or *silica* cannot be melted, however small fragments of them be employed." Now although I have not yet succeeded in producing large globules of fused silica, yet any person, by adopting the above expedients, may convince himself that the degree of heat thus obtainable is adequate for the fusion of silica. My experiments were made with chemically pure precipitated silica, and with a fragment of a colorless transparent crystal of quartz, from Herkimer county, New York, finely pulverized in an agate mortar. By taking a small platinum wire, bent as above, first fusing the end into a globule, then moistening this globule with saliva, or better (in order to avoid the introduction of any trace of *basic* contamination, which might be supposed to form a fusible silicate), with *syrup* made from pure sugar, and dipping it into the powder, then gently heating and incinerating in the flame of a spirit lamp, the silica powder remains loosely attached to the wire, and under the lens appears now perfectly impalpable and devoid of transparency. If now the potash-tube blowpipe, with paraffine candle flame, be brought to bear upon it for a minute, the silica being held a little way *outside* of the point of the blue cone, which in this kind of flame appears to be the hottest point, it will then be found strongly adherent to the wire, as if melted fast, and under the lens presents the appearance of small, transparent, irregularly shaped globules, *fused fast* to the platinum. I have little doubt that with a large paraffine candle, and larger jet, a *splinter of quartz* might be fused.†

The above mode of obtaining a high heat is essential to the practicability of a peculiar mode of manipulation that I have devised, and which I shall proceed to describe.

* Whitney's Translation, page 46.

† Berzelius, in a note, mentions an announcement of H. de Saussure that he melted *quartz*, supported on a slip of *kyanite*, with a jet of air from a *double bellows* through the flame of a thick *wax candle*; adding, however, that he suspects that the support may have produced an effect on the assay, and that the air from the bellows, being purer than that of the lungs, may have also contributed to effect a result which cannot be obtained by the mouth blowpipe."—*Whitney's Translation*, p. 54.

Many minerals and artificial products, when dissolved in a borax bead *in large quantity*, cause the bead to become opaque and milky on cooling, forming in fact an *enamel*, instead of a glass. Some of these are *lime*, *magnesia*, *baryta*, *strontia*, *glucina*, *oxyds of zinc*, *cadmium* and *cerium*, *tungstic* and *titanic acids*, *calcite*, *magnesite*, *dolomite*, *witherite*, *baryto-calcite*, *strontianite*, *gypsum*, *epsomite*, *heavy spar*, *celestine*, *goslarite*, *smithsonite*, *fluor spar*, *apatite*, *sphene*, *aeschynite*, *polymignyte*, *yttro-tantalite*, *scheelite*, *scheeletine*, *xenotime*, *yttro-cerite*, *fluocerite*, *cryolite*, &c. A great many more render the bead of *microcosmic salt* opaque or opalescent on cooling, and as some reactions, for instance that of *titanic acid*, are much more easily obtained in this than in the borax bead, these cases are also frequently of importance.

Now when it is desired to detect another substance occurring in small quantity in any of the above, such for instance as *manganese*, *copper*, *cobalt*, or *titanium*, by the color imparted to the bead after cooling, it is frequently impossible to do so, for the reason that if enough is added to give a decided reaction, the bead becomes opaque on cooling and the color cannot be seen.* In considering the cause of this loss of transparency, it seemed to me that it must be a granular *crystallization*, and remembering the fact that even *common glass*, if made to cool very slowly from fusion, becomes opaque and enamel-like, with many other familiar facts of an allied nature, it occurred to me that the converse of this phenomenon might also take place, or that an enamel which becomes transparent and vitreous when fused might retain its transparency when *suddenly* cooled. I was thus led to dip a bead composed of a highly basic borate of lime enamel into cold water while still fused. The result verified the hypothesis. The bead when cooled in this way remained transparent, and manganese was thus distinctly detected in a purely white marble, in which its presence could be distinctly pronounced upon otherwise only by Crum's test.

For a number of years I have had constant occasion to use this expedient, and have found it a highly valuable one. Blowpipe operators will need no further remarks upon the importance of such an addition to our facilities for investigation. It is necessary, however, that careful examination be made of all special cases, a work of time and patience, which I hope, nevertheless, soon to take up systematically.

As before intimated, it is necessary, or at least highly conducive, to the success of this new manipulation, to have means, such as are above detailed, of obtaining an increased heat; be-

* Speaking of *red zinc ore*, Berzelius says that it is dissolved by phosphorus salt, but that "the color of oxyd of manganese cannot be obtained till the glass has dissolved so large a quantity that it is no longer transparent on cooling."—*Whitney's Translation*, page 116.

cause these supersaturated beads, which *enamelize* (if I may be allowed to coin a new but convenient word) on spontaneous cooling, require a much higher temperature for fusion than those which remain vitreous, and without some additional facilities for obtaining this higher heat, the tax upon the time and patience of the analyst becomes very onerous, and in many cases I have found it in fact *impossible* to succeed by the ordinary mode, for when the bead is very highly basic, it must be heated considerably *above* its point of fusion, or it solidifies to an enamel immediately on removal from the flame. It was this necessity which led me to devise the above modes of increasing the heat. It is by no means necessary, however, in ordinary cases, to use *all* of the expedients described. In fact, for the fusion of most of these borax enamels, the *bent wire* [alone, with an ordinary blowpipe and an alcohol or gas flame, will suffice, and most others need only the additional assistance of the paraffine candle.

Whilst upon this subject of the blowpipe, I may be pardoned for offering briefly another suggestion. While making the experiments upon the reciprocal neutralization of the colors of metallic solutions, described in a former paper,* it struck me that the same principle should have applications in blowpipe analysis. It *must be* that when several metallic oxyds are present in a glass their several colors must interfere with each other in certain ways, and if we knew how to eliminate one or more of these colors by adding a neutralizing ingredient, so as to render others apparent, might it not furnish us with new facilities for research, and enable us to avoid old sources of error? I may conclude by noticing two or three results, which I have obtained, bearing upon this question. A deep amethystine bead of manganese glass acquired, on addition of a little oxyd of chrome, a *gray* color, resembling that produced by a mixture of solutions of chlorid of cobalt and chlorid of chromium, without any tinge of either red or green; a trifling additional quantity of oxyd of chrome giving, however, a distinct green color.† Another manganese bead gave a similar gray color on addition of oxyd of copper, but a slight excess of the latter imparted then a *blueish* tinge, which might easily be attributed to a trace of *cobalt.* The presence of nickel does not affect the blue color of a cobalt glass, as it does the rose color of cobalt in aqueous solutions, unless its quantity, compared with that of cobalt, is very great.

* Am. J. Science [2], xxvi, 49.

† In the decoloration of *ferriferous glass* by the addition of deutoxyd of manganese, "glass-makers' soap," is the action *wholly* due to the conversion of the ferrous into ferric oxyd, or *partly* also to the neutralization of a portion of the green ferrous color by some violet manganese glass formed?

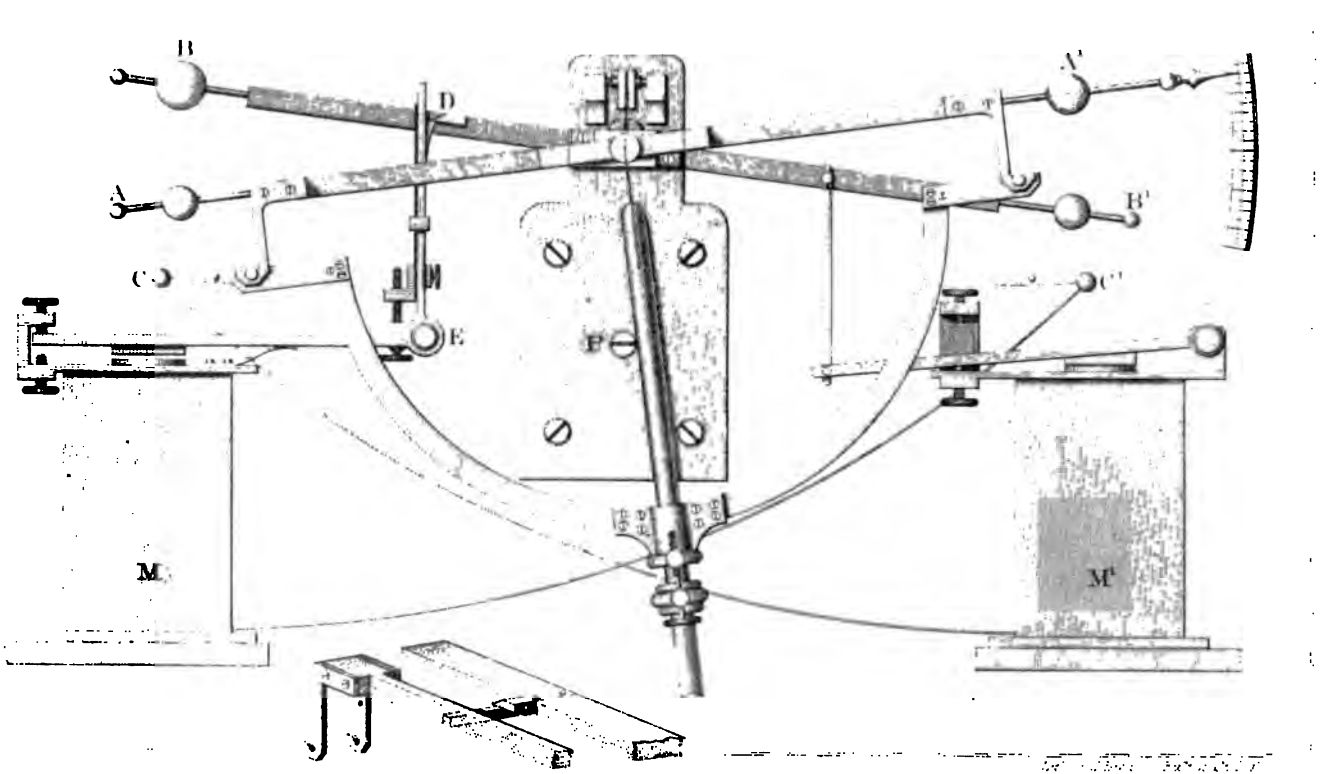
ART. XXII.—*On the Pendulum;* by F. A. P. BARNARD, President of the University of Mississippi,—*with a description of an Electric Clock,* constructed by E. S. RITCHIE, of Boston, for the University of Mississippi, under the direction of President Barnard.—With a Plate.

[From the Proceedings of the American Association at Baltimore, 1858.]

THE importance of the pendulum as an instrument for the measurement of time, is sufficient to justify any amount of effort which may be made to secure the regularity of its performance. The causes which disturb this regularity exist partly in the nature of things, and are partly introduced by the contrivances employed to maintain the motion of the instrument. Among these, the effect of varying temperature in altering the distance between the centre of oscillation and the point of suspension, is one which has given occasion to many ingenious inventions; yet, however effectual some of these may have been in removing the irregularity due to this cause, it is probably true that no plan of compensation has been found in practice to be entirely satisfactory. It is an opinion entertained by the writer, though it is proposed with some diffidence, that the problem of compensation cannot be experimentally studied with results to be perfectly relied upon, so long as the pendulum has any *work to do;* and this must be the case whenever the maintaining power is derived, directly or indirectly, from a train of wheel-work. The different forms of anchor or pallet escapement involve friction upon the pallets, which, however nearly constant it may be, cannot be wholly so, and however slight it may be, either absolutely or in its variations, cannot be altogether insensible as a disturbing cause. For small as may be the amount of fluctuation in this resistance, it is to be considered that all the quantities concerned in the question of maintaining the motion of the pendulum are small, and that every minute variation is multiplied thousands of times. But a more serious cause of irregularity in the pendulum directly driven by a train, is to be looked for in the varying condition of the train itself, and of its lubricants; in consequence of which the power of the prime mover is to some extent absorbed, and is at different times unequally communicated to the pendulum.

When we attempt to study, in the actual performance of the pendulum, the efficacy of any plan of compensating the effects of temperature, it is impossible entirely to distinguish the irregularities due to one cause from those which may proceed from another. Cold, for instance, by stiffening the lubricants may cause the clock to gain, and this effect may be erroneously ascribed to an under-compensation of the contraction of the

DIAGRAM OF AN ELECTRICAL CLOCK DESIGNED BY PROF F. A. P. BARNARD.



pendulum-rod. And though, in such a case, if the clock should run more slowly than in warmer weather, we might justly infer an over-compensation to exist, we should be unable to determine exactly the excess.

The partial or total failure in practice of plans of compensation theoretically perfect, has been sometimes attributed to the unequal rapidity with which changes of temperature take place in different parts of the same pendulum. Every plan of compensation is necessarily founded on the supposition that, under all alterations of temperature, the temperature throughout the entire instrument is simultaneously the same. It is easy to see, for example, that if the mercury employed to compensate the pendulum of a common astronomical clock were to be wholly inclosed in a cylinder of some material entirely impervious to heat (supposing such a material to exist), it would be altogether useless for the purpose intended. And that which would thus be true, on the supposition that the mercury could not change its temperature at all, must be measurably so, if its changes of temperature lag behind those of the rod. Glass jars for containing the mercury in pendulums of this construction have been objected to, on the ground that they do introduce an irregularity of this sort; and accordingly Mr. Dent, the distinguished practical horologist of London, introduced in place of them cylinders of iron. The objection has been founded, I believe, rather upon the observed performance of the pendulums, than upon actual observation of the relative temperatures of the mercury and the rod. It would seem not to be difficult to arrange a pendulum with thermometers which should show constantly the true temperature both of the mercury and of the rod. And considering the importance of the question involved, such an experiment would appear to be well worth making, before pronouncing the mercurial compensation to be unsatisfactory, or even condemning the glass cylinders.

The escapements called remontoirs apparently set the pendulum free from most of the liabilities to disturbance which the train introduces. In clocks provided with these escapements, the force of the train itself is exerted not in impelling the pendulum, but in raising a small weight, or bending a slight spring, which subsequently acts—the former in its descent or the latter in its recoil—in moving the pendulum. The gravity-remontoir apparently furnishes an impelling force which is perfectly uniform, there being nothing but the very slight friction on the pivots of the arms carrying the remontoir weights to disturb this uniformity. The spring-remontoir is free from even this source of disturbance, but is open to a more serious objection, in consequence of the varying elasticity of the spring occasioned by change of temperature. Both of these contrivances, however,

impose a certain duty on the pendulum, which is, to unlock the train at the moments when it is necessary that the remontoir motor should be raised. This cannot be done without friction, although the friction is less than in the case of pallet escapements. It is also true that, in proportion as the friction required to unlock is reduced, these escapements become liable to the accident of failing to lock—or of *tripping,* as it is technically called —whereby error is introduced into the time shown upon the dial.

Of all these escapements, remontoir escapements and pallet escapements alike, it may finally be said that they require the pendulum to swing through a certain arc larger than would be necessary if the maintaining power could be applied to it from without, leaving it subject to no disturbances whatever, beyond those occasioned by the varying temperature and density of the air. The usual extent of the arc of vibration is 2° on each side of the vertical. About one quarter of this distance is required merely to unlock the train of the remontoir. If now, at a definite point of the swing, a light weight could be deposited upon an arm projecting from the pendulum rod, allowed to remain there during the descent, and then removed, and if this could be repeated on one side and on the other alternately, with perfect regularity and at precisely the same distance always from the centre of motion, and if this could be done without any friction or concussion, we should have a pendulum subject to no forces accelerating or retarding but such as may be accurately estimated in their amount, and in their effects upon the time of vibration.

I do not overlook the fact, that the manner of suspending the pendulum may have some influence on its performance. But as the suspension is almost invariably by means of a very flexible but also very elastic spring, the effect due to the resistance of this spring in the ascent may be considered as neutralized, so far as regularity of vibration is concerned, by its recoil in the descent; and for the variations of its elasticity with change of temperature, a special compensation may be made.

The problem which is here proposed, seems to present a condition difficult to be fulfilled. The impulse is to come at the proper moment, but the pendulum is to do no work in order to induce it. Yet it can be nothing but the pendulum itself which is to determine the moment of application; since if we possessed any independent mechanism sufficiently regular to do this, we should have no need of the pendulum. It is believed that the difficulty which this consideration presents has been overcome.

The clock which is herewith presented for the examination of the Association is one in which electricity is made to work a remontoir apparatus, by which very slight weights are made to impel the pendulum, alternately, on either side. There is nothing new in the idea of an electric clock; but there is something

iently novel in a clock in which the pendulum does abso-
y no work at all (not even in making battery connections),
serve attention. There have probably been as many varie-
of electric clocks as of escapement clocks—conceived, at
, if not constructed. All of these known to the writer, in-
e as much friction as the dead-beat escapement—most of
: a great deal more—or else are otherwise objectionable.
; which seems to be least so, is a contrivance described in
third volume of Becquerel's Electricity, and attributed to
Vérité, in which two light balls are suspended by metallic
ads to a horizontal lever oscillating on pivots placed just
'e the point of suspension of the pendulum. Two arms from
pendulum alternately touch these balls, closing a battery cir-
by the contact. The corresponding end of the oscillating
r is thereupon depressed, relaxing the suspending thread, so
the ball presses upon the pendulum arm until the latter is
ed by the swing out of its reach; when, the circuit being
en, the lever rights itself again. Ingenious as this arrange-
t is, the objections to it are too obvious to require enumera-
. It furnishes a force which fails in the three essential
isites,—perfect uniformity in quantity, uniformity in dura-
, and uniformity in the point of application. The suspending
ad, however flexible, must interfere with the first of these
litions, and the agitation produced by the sudden tilting of
lever must affect the other two.

he construction of the clock herewith exhibited, may be ex-
ned by reference to the accompanying diagram, (see Plate,)
ch shows the upper portion of the pendulum rod with the
rivance employed to apply the impelling weight. Two lev-
are represented, marked *A A'* and *B B'*.

he first of these, from its office, is called the remontoir lever
e second, which is employed to control the first, is called the
ernor. The former is provided at each of its extremities
i two hooks (as shown in perspective at the bottom of the
ram). These hooks are designed to carry a very light
ght in the form of a small cylinder of metal. This cylinder
ightly indented in the latter at the points where it rests on
hooks, to prevent liability to displacement.

he pendulum-rod is furnished with two semicircular arms, to
ch, at their extremities, are attached two parallel plates of
al which pass between the hooks of the remontoir lever, and
ive the weights, at the proper moments from the hooks,
g also slightly notched or indented, to secure uniformity in
rd to the point of application of the force.

oth the levers are pivoted in agates, their pivots being in the
e horizontal line as the centre of motion of the pendulum.
y are also provided with adjustable weights at their extremi-

ties designed to make them tilt slowly in one direction or the other, as may be necessary in order to apply the impulse on either side of the pendulum at the proper moment.

The remontoir lever, when free from control by the other, tends to preponderate toward the right. The governor has a sufficient preponderance in the opposite direction to carry the remontoir with it, when in action, by means of a projection seen at D, which overlaps a corresponding projection on the other, as shown in perspective at the foot of the diagram. This lever in the position exhibited, is caught by a detent at D, and the remontoir lever is free to tilt toward the right, in doing which, it will carry the impulse weight of the extremity A along with it, while it will leave that at the extremity A' on the higher arm of the pendulum. In its swing toward the left, the pendulum will then be impelled by this small weight until it reaches a corresponding inclination on that side, when it will deposit the weight A' upon the hooks of the remontoir, and will take up the other upon the opposite arm.

This mechanism is so simple as to require no further explanation. It only remains to point out in what manner the levers are controlled by the electric battery.

The remontoir lever is insulated by the agates in which it turns. By a tangent spring at its axis it is put into the battery circuit. It has no other contact with the mechanism except where it is acted on by the governor; at which point insulation is also effected; and likewise through the springs shown at C and C', upon which the hooks remotest from the observer alternately rest. These springs are fixed in insulated pins to which are soldered the extremities of the enveloping wires of the magnets M and M'. The pin C is connected with the magnet M', and the pin C' with the magnet M. The continuation of these wires beyond the magnets is not shown; but they are united into a single one, which, after enveloping a third magnet in the time-register (of which no drawing is given), returns to the battery.

From what has thus far been said, it would appear that the moment the hook of the remontoir lever touches either of the springs, C or C', the battery circuit would be complete. But this is not the case: for the hook in contact with the spring is insulated from the lever, and the circuit is only completed at the moment when the pendulum, in its swing, deposits the impulse weight upon the two hooks.

In the position shown, the weight A is supposed to have just been deposited. The magnet M' has acted and has raised the extremity B of the governor to the detent, D. The remontoir lever will now slowly tilt, the gentle motion being necessary to prevent the impulse weight from being thrown off; and the balance weights being so adjusted as to secure the necessary

change of position within the second. A stop prevents the spring *C* from following the hook as it rises.

When the impulse weight *A'* is deposited on the hooks, it is the magnet *M* which acts; and the effects of this, through the bent lever pivoted at *E*, is to release the governor, which, by its preponderant weight will cause the remontoir to tilt again.

Whenever either magnet acts, the magnet of the time-register simultaneously acts, and advances the second-hand one division on the dial.

The remaining parts of the mechanism it is hardly necessary to describe. Adjusting screws are provided to secure the exact position of the pendulum arms, and to cause the impulse to be precisely equal in duration on opposite sides. In adjusting for this latter purpose, the graduated arc on the right, and the index attached to the remontoir lever, are employed. The manner of making the adjustment is obvious.

A pendulum impelled in this manner is subject to the action of no forces which cannot be definitely appreciated. The impelling power is constant and known. The mean resistance of the air may be computed, and even its fluctuations may, if necessary, be taken into account. The irregularities, therefore, which cannot be ascribed to these causes, must be due to imperfect compensation.

There is a possibility that a steel pendulum rod may, to some extent, be affected by the vicinity of the electro-magnets employed in this contrivance. In order to guard against this danger, if it be one, the rod of the pendulum of the clock, here exhibited, is made of brass; and the compensation, which is mercurial, is adjusted accordingly.

The effect of the impelling and resisting forces acting upon a pendulum is to alter its rate of motion; but this circumstance is of no importance, so long as these forces are invariable, like gravity. If, however, any variation occurs, either in the impulse or in the resistance, the time of vibration will be altered. The kind of alteration which occurs, in consequence of a given change of arc, is not, nevertheless, the same, with pendulums impelled on different plans. The recoiling escapement, for instance, accelerates the rate for an increase of arc, while the dead beat retards it beyond the amount which would be due to circular motion, as compared with motion in the cycloid.

The remontoir escapement has the advantage that, though it accelerates the rate of going of the pendulum, it applies invariably the same amount of impelling force at every swing; so that if the pendulum had no work to do in the unlocking of the train, it would be subject to no disturbance of its regularity except such as may be consequent upon fluctuations of atmospheric

density, and upon changes in its own temperature. In studying experimentally the subject of compensation, it would not be difficult to eliminate the effects of the first of these causes, so as to exhibit truly the merit or defect of any given mode of compensation for the expansion and contraction of the materials of the pendulum.

The remontoir escapement does not perfectly fulfil these conditions; but it is believed that the electric clock herewith presented does so completely.

This pendulum has an additional advantage over an escapement remontoir; which arises from the fact that its arc of vibration may be reduced much lower than is at all practicable with a clock driven by a train. All the errors of the pendulum, except those arising from the varying temperature of the rod, increase with the arc. It is believed that this pendulum may be run with so small a motion as to make such errors quite insensible. The degree, moreover, to which external forces affect the rate without altering the arc, is proportional to the forces themselves; and these, in the present case, must necessarily be less as the arc is less.

In order to show in what manner a pendulum of this description differs in its rate of going from one entirely free and vibrating in vacuo, we may take the ordinary differential equation of the angular motion of an oscillating body, and introduce into it terms expressing the forces which in this case are in action, besides gravity. This equation then becomes (φ being the variable arc, measured from the vertical, t the time of one vibration, g the force of gravity, l the length of the simple pendulum, m the maintaining and r the resisting forces, or rather their constant coefficients as compared with gravity).

$$\frac{d^2\varphi}{dt^2}=-\frac{g}{l}\left(\sin\varphi-rf(\varphi)+mf'(\varphi)\right).$$

The maintaining force, in the present case, is a weight applied at the extremity of an arm of the pendulum at the height of the centre of motion. Represent the weight by w, the length of the arm by a, and the total mass of the pendulum by M, and we have the value of m equal to $\frac{wa}{Ml}$. The function of φ on which its effect depends is obviously the cosine.

The resistance is, in this case, nothing but the atmospheric inertia, so long as the impulse lasts; after this, the maintaining weight becomes itself a resisting force, and its sign must be changed. The resistance of the atmosphere may be computed on the supposition that the velocity with which a falling body, of equal weight with the pendulum, and presenting an equal surface of resistance, ceases to be accelerated by gravity, is

known. This velocity may be represented by k. Then $rf(\varphi)=\frac{v^2}{k^2}$. For the value of $f(\varphi)$, we consider the velocity to be that which a body would acquire in falling vertically through the height the pendulum has descended from the commencement of its motion, which (if α represent the limit of vibration) is

$l(\cos\varphi-\cos\alpha)$. Then $v^2=2gl(\cos\varphi-\cos\alpha)$, and

$$rf(\varphi)=\frac{2gl}{k^2}(\cos\varphi-\cos\alpha).$$

The equation then becomes

$$\frac{d^2\varphi}{dt^2}=-\frac{g}{l}\left(\sin\varphi-\frac{2gl}{k^2}(\cos\varphi-\cos\alpha)+\frac{wa}{Ml}\cos\varphi\right).$$

If we suppose the impulse to continue to the distance β on the other side of zero, and integrate between the limits α and $-\beta$, we shall have (employing the simpler symbols for the sake of convenience)

$$\frac{d\varphi^2}{dt^2}=2\frac{g}{l}\Big[\cos\varphi-\cos\alpha+(m-r)(\sin\alpha-\sin\varphi)+r\cos\alpha(\alpha-\varphi)\Big].$$

Replacing the trigonometrical functions by their values in terms of the arcs, and rejecting minute terms of higher orders than the second, we shall obtain, after reduction,

$$\frac{d\varphi^2}{dt^2}=\frac{g}{l}\Big[\alpha^2+2m\alpha-2m\varphi-\varphi^2\Big].$$

Hence,

$$dt=\sqrt{\frac{l}{g}}\frac{-d\varphi}{\sqrt{\alpha^2+2m\alpha-2m\varphi-\varphi^2}},$$

$$t=\sqrt{\frac{l}{g}}\times-\text{arc}\sin\frac{\varphi+m}{\alpha+m}+C.$$

And, between the limits α and $-\beta$,

$$t=\sqrt{\frac{l}{g}}\left(\frac{\pi}{2}-\text{arc}\sin\frac{-\beta+m}{\alpha+m}\right).$$

In like manner, if t' express the time during which the impulse weights oppose the motion,

$$t'=\sqrt{\frac{l}{g}}\left(\frac{\pi}{2}-\text{arc}\sin\frac{\beta+m}{\alpha+m}\right).$$

Putting $\tau=t+t'$, the total time of vibration,

$$\tau=\sqrt{\frac{l}{g}}\left(\pi+\text{arc}\sin\frac{\beta-m}{\alpha+m}-\text{arc}\sin\frac{\beta+m}{\alpha+m}\right).$$

Developing these arcs in terms of their sines, according to the ordinary series, taking their difference, and expressing by $\Delta\tau$ the difference between τ and the time of vibration of a free pendulum,

$$\Delta\tau = -\sqrt{\frac{l}{g}}\left[\frac{(\beta+m)-(\beta-m)}{(\alpha+m)} + \frac{1[(\beta+m)^3-(\beta-m)^3]}{2.3\,(\alpha+m)^3} + \frac{1.3\,[(\beta+m)^5-(\beta-m)^5]}{2.4.5\,(\alpha+m)^5}, \text{\&c.}\right];$$

which becomes, if we neglect insignificant terms,

$$\Delta\tau = -\frac{2m}{\alpha+m}\sqrt{\frac{l}{g}}\left[1+\frac{\beta^2}{2.\alpha^2}+\frac{\beta^4}{2.4\alpha^4}+\frac{\beta^6}{2.4.6\,\alpha^6}, \text{\&c.}\right] \qquad (1)$$

If $\sqrt{\frac{l}{g}}=\frac{1}{\pi}$, as for the free pendulum beating seconds, then, putting ΔT for the total acceleration of the clock in making the number of beats made by the seconds pendulum in a day, and calling the entire remaining value of the second member of the last equation S,

$$\Delta T = \frac{86400\,S}{\pi}. \qquad (2)$$

The terms containing r having disappeared from these expressions, it would seem that the resistance of the air does not affect the time of vibration. These terms, however, have not been eliminated, but only neglected, in consequence of being connected with powers of the arc higher than the square. By preserving them, it may be shown that the resistance of the air produces an effect which is not altogether insensible; rather, however, by consuming some of the disturbing power of m, than by its direct influence. The reason of this is, that the resistance of the air opposes gravity during the descent of the pendulum, but favors it during the ascent.

The value of the foregoing series depends upon the impelling power, and on the ratio between the arc of impulse and the arc of vibration. The necessary impelling force itself, when the ratio just mentioned is fixed, depends upon the absolute magnitude of the arc α. If we assume this arc at two degrees, which is ·035 of the radius taken as unity, and make the ratio of β to α =·7071, as recommended by Mr. Denison, in his rudimentary treatise on clock and watch work, we may compute the value of m by the following process:—

Assume the pendulum to weigh twenty pounds, which is not far from the weight of that of the clock exhibited; and suppose it to expose a resisting surface to the air of thirty square inches. A column of air of equal base and weight would be about 1250 feet in height, and the velocity with which a fluid of this altitude

would issue from a vessel in consequence of the superincumbent weight, is determined by the formula

$$v^2=2gh.$$

Were the pendulum therefore to move with a velocity equal to the square root of $2\times 32\times 1250$ (=80,000), the resistance would be equal to its weight. Hence,

$$k=\sqrt{80,000}.*$$

And $r(\cos\varphi-\cos\alpha)=\frac{2gl}{k^2}\times\frac{\alpha^2-\varphi^2}{2}=\frac{gl(\alpha^2-\varphi^2)}{80,000}.$

This being the coefficient of the variable resistance, the total effect of the resisting force may be found by integrating the expression,

$$\frac{gl(\alpha^2-\varphi)^2}{80,000}g\,dt,$$

between the limits α and $-\alpha$. Employing the symbol r, instead of the fractional coefficient, and taking the value of dt as given above, we have, calling the total resistance R,

$$R=\int\frac{rg}{2}(\alpha^2-\varphi^2)\sqrt{\frac{l}{g}}\frac{-d\varphi}{\sqrt{\alpha^2+2m\alpha-2m\varphi-\varphi^2}}.$$

Integrating between the limits α and $-\alpha$, and putting $\sqrt{\frac{l}{g}}=\frac{1}{\pi}$,

$$R=\frac{rg}{2\pi}\left[\left(\frac{\alpha^2-2m\alpha}{2}\right)\left(\frac{\pi}{2}+\arcsin\frac{\alpha-m}{\alpha+m}\right)+(\alpha+3m\sqrt{m\alpha})\right].$$

Since m is very minute in comparison with α, we may make $\frac{\alpha-m}{\alpha+m}=1$, and also neglect $-2m\alpha$. The small positive term at the end becomes insensible, when multiplied by the general coefficient, in which k^2 is a divisor—the term itself being insignificant compared with π, with which it is connected by the sign +. The errors thus introduced, besides being insensible, are in opposite directions, and nearly balanced. The simplified expression is then,

$$R=\frac{rg\alpha^2}{4}=\frac{g^2l\alpha^2}{2k^2}.$$

This resistance extends over the whole arc of vibration; but the maintaining power acts effectively only between the limits β

* This computation supposes the resisting surface to be plane. The actual value of k will vary with the form of the pendulum; and will ordinarily be considerably greater than it is here found to be. The disturbing effects upon the pendulum, deduced further on, will therefore be materially less than represented; since a less impelling force will be required to maintain the motion than the calculation exhibits. The actual value of k may be pretty nearly ascertained for bodies of regular shape, by considering the inclination of their surfaces to the direction of motion.

and $-\beta$, or during the time found by integrating the expression already given for $d\,t$ between the same limits. Then,

$$mg(t-t') = \frac{2mg}{\pi}\left[\frac{\beta}{\alpha} + \frac{1.\beta^3}{2.3\alpha^3} + \frac{1.3\beta^5}{2.4.5\alpha^5} + \frac{1.3.5\beta^7}{2.4.6.7\alpha^7}, \&c.\right] \quad (4)$$

Or, putting S for the sum of the series within the brackets,

$$m\,g\,(t-t') = \frac{2\,m\,g\,S}{\pi}, \text{ which must equal } R.$$

Therefore,

$$\frac{2\,m\,g\,S}{\pi} = \frac{g^2\,l\,a^2}{2\,k^2}; \text{ and } 4\,Sk^2\,m = g\,l\,a^2\,\pi,$$

Whence,

$$m = \frac{w\,a}{M\,l} = \frac{g\,l\,a^2\,\pi}{4\,S\,k^2}; \text{ and } w = \frac{Mg\,l^2a^2\pi}{4\,a\,S\,k^2}. \quad (5)$$

The foregoing series rapidly converges, and if $\beta = {\cdot}707\,\alpha$, its sum is $\frac{1}{4}\,\pi$. Putting α, the length of the pendulum arm, measured at right angles to the pendulum rod from the centre of motion, = 3 inches, and employing for the other symbols, the values heretofore given, we shall obtain for m and w the numerical values,

$$m = {\cdot}000001597.$$

$$w = 2{\cdot}914 \text{ grains, or 3 gr. nearly.}$$

Returning to the expressions (1) and (2), with the value of m thus determined, and still employing for β the value ${\cdot}707\,\alpha$, the sum of the series within the brackets in (1) will be found to be 1·384. And therefore $\varDelta\,T$, or the daily acceleration, will be,

$$\varDelta\,T = \frac{2 \times 86400 \times {\cdot}000001597 \times 1{\cdot}384}{3{\cdot}14159 \times {\cdot}035001597} = 3{\cdot}473 \text{ seconds.}$$

Whence it appears that this pendulum, in order to beat seconds, must be about three one thousandths of an inch longer than one entirely free.

In order to investigate the liability of this pendulum to change of rate, we must observe that, at a constant temperature, it is impossible that there should be a change of rate without a change of the arc of vibration; and further, that there is no cause in operation to change the arc, except variations of density in the air. In expression (5) we observe that a^2 varies as k^2; but it is evident that k^2 varies inversely as the density of the atmosphere. Or, putting D for the density,

$$a^2 \propto k^2 \propto \frac{1}{D}.$$

$$2\,a\,d\,a \propto 2\,k\,d\,k \propto -\frac{d\,D}{D^2}.$$

Hence,

$$\frac{2\,d\alpha}{\alpha} \propto \frac{2\,dk}{k} \propto -\frac{dD}{D}.$$

And,

$$\frac{d\alpha}{\alpha} \propto -\frac{dD}{2D}.$$

Putting the mean density of the air $=1$, and substituting a finite difference for dD, we shall find that the corresponding finite difference of α will be but half as great in proportion to the entire arc, as the fractional change of density. If, therefore, under a constant temperature, the mercury in the barometer rise or fall one inch, or a change of density occur equal to one thirtieth of the mean, the arc of vibration will change one sixtieth part of the whole; that is to say, if the value of α is 2°, the arc will fall off, or increase to the amount of 2′.

To compute the effect of such a change upon the quantity ΔT, we may regard the series in equation (1) as being sensibly constant, and then, representing the whole expression, except the denominator of the coëfficient fraction, by Q, and omitting the insignificant term m from the denominator, we shall have,

$$\Delta\,T \doteq -\frac{Q}{\alpha}, \text{ and } d\,\Delta\,T = \frac{Q\,d\alpha}{\alpha^2}.$$

Substituting $-\alpha\,\Delta\,T$ for Q and reducing, we have,

$$d\,\Delta\,T = -\frac{\Delta\,T\,d\alpha}{\alpha},$$

which, in the extreme case supposed above, gives a diminution of the daily acceleration equal to ·058 sec. This change is, unfortunately, in the same direction as that of the circular error: but it is proportional to the quantity $\Delta\ T$ itself, which is directly as the maintaining power; which, again, as appears from equation (5), is as the square of the arc. Hence, therefore, the importance of reducing the arc of vibration, and the near approach to insensibility of the errors arising from its variations, when it is small. Were the arc only 1° on each side of the vertical, the error would be between one and two hundredths of a second per day. Were it half a degree, the clock, from this cause, would not be an entire second in error in nine months.

The chief object had in view in the construction of the electric clock herewith exhibited, has been to secure the reduction of the arc of vibration. The work having just been completed, opportunity has not yet been allowed for experimentally deciding the question how great a reduction of arc is practicable; but the principle of the mechanism exacts no larger motion than

may be necessary to make and break electric contacts. The reduction of the arc α may be equally effected by either of two methods—either by reducing the impulse weights, or by shortening the duration of the impulse. When the arc is considerable, the former method appears preferable; when it is very small, there is not much to choose between the two; except that, by constantly reducing the impulse weights, they may perhaps become inconveniently small.

To return to the subject of compensation for variations of temperature, it may be observed that, while every pendulum is liable to be disturbed by the forces other than gravity acting upon it, and while these forces are not all of them subject to law, so that their effects can be exactly predicted and allowed for, it is not surprising that methods of compensation theoretically good should have failed to satisfy in practice. In the electric clock here presented, should its performance accord with expectation, and should it be found practicable to reduce the arc of vibration as far as it is at present believed to be, there will evidently be no sensible change of rate arising from any cause whatever, except expansion or contraction. If then the rate does actually change, the cause of error will be directly indicated; and the proper mode of correction may be made a subject of intelligent study.

A doubt has been already intimated above, whether the complaint made of the performance of the mercurial compensation, and of the glass jars as connected with it, is well founded. If the pendulum rod descends into the mercury, it would seem that there could be no great difference in the fluctuations of the temperature of the two metals. As the changes come from without it will be the rod which will be most directly exposed to them; but the capacity of the mercury for heat is so much less than that of steel, that its changes take place with correspondingly greater rapidity. If the smaller bulk of the rod in proportion to its surface, be in its favor, the remedy would be to make the rod larger, or to dispose the mercury in an annular vessel. But, at any rate, it is easy to make the containing vessel of iron according to the plan of Mr. Dent; and if this is done, and the expedient last suggested is adopted, of introducing the mercury into the annular space between two cylinders, it would seem that the mercurial compensation might be made quite perfect. As a final security against irregularities in the receiving of heat or parting with it, the entire surface both of the rod and of the containing vessel might be made uniform in character: which is done in the present clock by gilding. For a comparison of the performance of the compensation in glass and in iron, different jars are provided, which will be substituted for each other at intervals of several months. A brass cover, externally gilded, is also

provided, to be placed over either the iron or the glass jar, for the purpose of observing the effect of change of external surface.

These are some of the arrangements which have been made for future use in the experimental examination of the question under consideration. They would not have been brought to the notice of the Association until after having been instrumental in securing some results, were it not for the fact that no other opportunity will occur of exhibiting the clock itself—its completion having taken place just as the Association are meeting—and the constructor being on the point of forwarding it to the University of Mississippi, where it belongs. The observatory of the university is now in progress of erection, and it will be some time before the large transit instrument which is to be provided will be set up. It will be practicable, however, with less perfect facilities, to make some of those observations for which this clock is designed; and the conclusions to which such observations may lead will be communicated hereafter.

Art. XXIII.—*Enumeration of Ferns collected by Mr. Charles Wright, in Eastern Cuba in* 1856–7; by Daniel C. Eaton.

This enumeration has been prepared for the benefit of the subscribers to Mr. Wright's Cuban collections. It is unavoidably imperfect, since my materials for identifying tropical ferns are scanty, and, indeed, I should not venture to print it, were it not for the kindness of Sir W. J. Hooker, who has examined and named for me several of the more obscure species. Mr. Wright is again collecting in Cuba: after his return a supplement to this list will probably be published.

774. Hemionitis palmata, *Linn.*

775. Antrophyum subsessile, *Kunze, Analect.* p. 29, t. 19.

776. A. lanceolatum, *Kaulf.*

777. Gymnogramme tartarea, *Desv.*

778. G. sulphurea, *Desv.*

779. G. trifoliata, *Desv.*

780. Xiphopteris serrulata, *Kaulf.*

781. Meniscium sorbifolium, *Willd.; Langsd. and Fisch. Ic. Fil.* t. 4.

782. M. sorbifolium, *Swartz.* This is probably but a variety of the last with narrower pinnæ.

783. Gymnopteris aliena, *Presl.* (Acrostichum alienum, *Swartz.*)

784 & 785. Olfersia cervina, *Kunze; Hook. Filices Exoticæ,* t. 43. (Acrostichum cervinum, *Swartz.*)

786. Polybotrya osmundacea, *Humb. & Bonpl.?*

787. Lomariopsis sorbifolia, *Fée, Hist. des Acrostichacées,* p. 69, var.? Perhaps this Fern deserves to be described as a new species, but I am unwilling to name and describe it from my present scanty materials.

788. Gymnopteris nicotianæfolia, *Presl.* (Acrostichum nicotianæfolium, *Swartz.*)
789. Elaphoglossum ciliatum, *T. Moore, Index Filicum*, p. 8. (Acrostichum Preslianum, *Fée, 2me. Mém.* p. 46, t. 24; *Hook. in litt.*)
790 & 791. E. latifolium, *J. Smith, Catal. Kew Ferns*, p. 3. (Acrostichum latifolium, *Swartz; Hook. Fil. Exot*, t. 42.)

The name Elaphoglossum is retained for this genus because there was no representative of it in the original genus Acrostichum, (*Linn. Amœn. Acad.* i, p. 268,) which contained only two real Acrostichaceæ, A. aureum and A. lanceolatum (Leptochilus Linnæanus, *Fée*), the former of which must keep the name Acrostichum.

792. Hymenodium crinitum, *Fée, 2me. Mém.* p. 90. (Acrostichum crinitum, *L.; Hook. Fil. Exot.* t. 6.)
793. Elaphoglossum.
794. E. piloselloides, *T. Moore, l. c.* p. 13. (Acrostichum piloselloides, *Presl.; Hook. l. c.* t. 29.)
795. Goniophlebium incanum, *J. Smith.* (Polypodium incanum, *Swartz.*)
796. Pleopeltis angustifolia. (Polypodium elongatum, *Mettenius, Polypod.* p. 88, non Pleopeltis elongata, *Kaulf.*)
797. Campyloneuron tæniosum, *Fée, Gen. Fil.* p. 258. (Polypodium tæniosum, *Willd.; Mettenius, l. c.*, p. 52.)
798. Goniophlebium piloselloides, *J. Smith, in Hook. Jour. Bot.* 4, p. 56. (Polypodium piloselloides, *L.*)
799. Campyloneuron.
801. C. Cubense, *Fée, Iconogr.* p. 14 and 129, t. 3. (Polypodium tæniosum, var. *Mettenius, l. c.*)
803. Phlebodium aureum, *R. Br.; Hook. Gen. Fil.* t. 112. (Polypodium aureum, *L.* Chrysopteris aurea, *Link, Fil.* sp. p. 121.)
804. Goniophlebium neriifolium, *J. Smith, l. c.* (Polypodium neriifolium, *Swartz.*) *Hook. in litt.*
805. Polypodium sororium, *H. B. K.*
806. P. pectinatum, *L.*
807. P. Funiculum, *Fée, Iconogr.* p. 12, t. 18.
808 & 810. P. suspensum, *L.; Hook. in litt.*
809. P. Camptoneuron, *Fée, Gen. Fil.* p. 237, *Iconogr.* p. 60, t. 23.
811. P. trichomanoides, *Swartz.*
812. P. hastæfolium, *Swartz; Hook. & Grev. Ic. Fil.* t. 203.
813. Goniopteris reptans, *Presl.* (Polypodium reptans, *Swartz.*)
814, 816 & 865. Polypodium (Phegopteris) sanctum, *Swartz.*
815. Lastrea pubescens, *Presl.* (Aspidium pubescens, *Swartz; Vid. Hook. & Grev. Ic. Fil.* t. 162.
817. Goniopteris tetragona, *Presl.* (Polypodium tetragonum, *Swartz; Schkuhr, Fil.* t. 18b. Phegopteris tetragona, *Metten. Fil. Lips.* p. 84.) *Hook. in litt.*
818, 819 & 822. Lastrea patens, *Presl.* (Aspidium patens, *Swartz.*)

This is a common and most variable fern in the Southern States from Florida to Louisiana and Texas. It resembles Nephrodium molle, and was mistaken for that species by *Kunze.* (*Am. Jour. Sci.* vi, p. 83.)

820. L. contermina, *Presl.* (Aspidium conterminum, *Willd.*) *Hook. in litt.*
823. Nephrodium deltoideum, *Desv.* (Aspidium deltoideum, *Swartz; Metten. Phegopt. und Aspid.* p. 93.)
824. N. Skinneri, *Moore, Index Filicum*, p. 104. (Aspidium Skinneri, *Hook. Ic. Pl.* t. 924.)?
825. N. stenopteris. (Aspidium stenopteris, *Kunze, Fil.* 2, p. 48, t. 120.)
826. Nephrolepis exaltata, *Presl.*
827. Goniophlebium loriceum, *Fée, Gen. Fil.* p. 255. (Polypodium loriceum, *L.*)
829. Polystichum triangulum, *Fée.* var. (Aspidium triangulum, *L.* var. laxum, *Hook. Fil. Exot.* t. 33. Polystichum ilicifolium, *Fée. Gen. Fil.* p. 279, *Iconogr.* p. 21, t. 6.
830. Lastrea Melanochlamys, *Moore, l. c.* p. 96. (Aspidium Melanochlamys, *Fée, Gen. Fil.* p. 294.)
831. L. exculta, *Moore, l. c.* p. 91. (Aspidium excultum, *Metten. Phegopt. und Aspid.* p. 69. Aspidium lætum, *Moritz.*) *Hook. in litt.*
832. Polystichum platyphyllum, *Presl.* (Aspidium platyphyllum, *Willd.* Phegopteris platyphylla, *Metten, l. c.* p. 122.)
833. Aspidium cicutarium, *Swartz; Metten. l. c.* p. 117.
834. A. macrophyllum, *Swartz; Metten. l. c.* p. 122.
835. A. trifoliatum, *Swartz.*
836. Oleandra nodosa, *Presl.*
837. Asplenium serratum, *L.; Hook. Fil. Exot.* t. 70.
838. H. marginatum, *L.; Hook. l. c.* t. 73. (Hemidictyum marginatum, *Presl.*)
840. A. serra, *Langsd. & Fisch. Ic. Fil.* t. 19.
842. A. dimidiatum, *Swartz.* (A. zamiæfolium, *Kunze, Fil.* p. 103, t. 48.)
833. A. falcato, *Lam.*, affine.
844. Fadyenia prolifera, *Hook. Gen. Fil.* t. 58, B; *Fil. Exot.* t. 36. (Aspidium Fadyenii, Mettenius, *Fil. Hort. Lips.* p. 95. Asplenium proliferum, *Swartz.*)
845. Asplenium, salicifolio, *L.* affine.
846. Diplazium grandifolium, *Swartz.; Hook. in litt.*
847. Diplazium.
848. Asplenium bidentatum, *Willd.* ?
849. A. auricularium, *Desv.*
850 & 851. A. rhizophorum, *Swartz; Hook in litt.*
852. A. bisectum, *Swartz.*
853. A. dentatum, *L.; Hook. & Grev. Ic. Fil.* t. 72.
854. A. formosum, *Willd.; Hook. Fil. Exot.* t. 16.
855 & 856. A. cicutarium, *Swartz.*
857. A. fragrans, *Swartz; Hook. in litt.*

858 & 859. Onychium strictum, *Kunze, Fil.* 2, p. 11; *Hook. Sp. Fil.* 2, p. 123.

860. Gymnogramme leptophylla, *Desv.*

861. Asplenium pumilum, *Swartz.*

862. Didymochlæna sinuosa, *Desv.* (D. truncatula, *J. Smith.*)

863. Blechnum occidentale, *L.*

864. Lomaria decresceus, *Fée, Gen. Fil.* p. 68, *Iconogr.* p. 24, t. 9. (L. attenuata, *Willd., ex Hook. in litt.*)

865. Vittaria lineata, *Swartz*—(the longer specimens.)

865bis. V. sp. ign.—(the shorter specimens.)

866. Pleurogramme immersa, *Fée. 3me. Mém.* p. 37, t. 4. *Hook. in litt.*

867. Pteris pedata, *L.; Hook. Sp. Fil.* 2, p. 208. *Fil. Exot.* t. 34. (Doryopteris pedata, *J. Smith.*)

868. P. leptophylla, *Swartz; Hook. Sp. Fil.* 2, p. 216. (Litobrochia leptophylla, *Fée, Gen. Fil.* p. 135.)

869. P. mutilata, *L.; Hook. l. c.* p. 164, t. 131.

870. P. denticulata, *Swartz; Hook. l. c.* p. 215. (Litobrochia denticulata, *Fée, l. c.*)

871. P. longifolia, *L.*

872. P. aquilina, *L.* var. caudata, *Hook. l. c.* p. 196.

873. P. aculeata, *Swartz; Hook. l. c.* p. 224. (Litobrochia denticulata, *Fée, l. c.*)

874. Adiantum macrophyllum, *Swartz; Hook. Fil. Exot.* t. 55.

875. A. trapeziforme, *L.*

876. A. tenerum, *Swartz.*

877. A. concinnum, *H. B. K.*

878. A. fragile, *Swartz.*

879. A. pulverulentum, *L.*

880. A. cristatum, *L.; Hook. in litt.*

882. A. villosum, *L.*

883. Pteris laciniata, *Willd.; Hook. Sp. Fil.* 2, p. 176, t. 132.

886. Polypodium (Phegopteris) barbatum, *Kunze in Linnæa*, 9, 52. *Hook. in litt.*

887. Cheilanthes microphylla, *Swartz.*

888. Hemitelia horrida, *R. Br.; Hook. Sp. Fil.* 1. p. 30, t. 15; *Fil. Exot.* t. 69.

889. Alsophila.

890. A. muricata, *Hook. in litt.*

891. Cyathea Serra, *Willd.* var.?

892 & 893. C. arborea, *Smith; Hook. Sp. Fil.* 1, p. 17.

894. Hypolepis repens, *Presl.*

895. Dicksonia cicutaria, *Swartz.*

896. Davallia polypodioides, *Don.*

897. Dicksonia Plumieri, *Hook. Sp. Fil.* 1, p. 72.

898. Davallia aculeata, *Swartz.*

899. D. uncinella, *Kunze, Fil.* 2, p. 96, t. 140.

900. Trichomanes crispum, *L.*

901. T. macroclados, *Kunze, l. c.* p. 72, t. 130.

902. T. Radicans, *Swartz; Hook. in litt.*

903. T. anceps, *Hook. Sp. Fil.* 1. p. 135, t. 40 ?
904. Hymenophyllum sericeum, *Swartz.*
905. H. hirsutum, *Swartz.*
906. 907 & 908. Trichomanes pyxidiferum, *L.* var.
909. T. angustatum, *Carm.; Hook. & Grev. Ic. Fil.* t. 166; *Hook. in litt.*
910. Metzgeria fucoides, *Nees & Montagne.*
911. Trichomanes membranaceum, *L.*
912 & 913. T. muscoides, *Swartz.*
914. T. apodum, *Hook, & Grev. Ic. Fil.* t. 117.
915. T. reptans, *Swartz.*
916. T. holopterum, *Kunze, Fil.* 1, p. 185, t. 77 ?
917. Hymenophyllum asplenoides, *Swartz.*
918. Hymenophyllum.
919. H. undulatum, *Swartz.*
920. H. abruptum, *Hook. Sp. Fil.* 1, p. 88, t. 31.
921. Gleichenia pubescens, *Willd.*
922. G. dichotoma, *Willd.*
923. Nephrodium Serra, *Desv. Ann. Linn.* 6, p. 253. (Aspidium Serra, *Swartz.*)
924. Danæa nodosa, *Smith; Hook. & Grev. Ic. Fil.* t. 51.
925. Lygodium Poeppigianum, *Presl. Suppl. Tent.* p. 103 ?
926. Schizæa dichotoma, *Swartz.*
927. Rhipidopteris peltata, *Fée. 2me. Mém.* p. 78. (Acrostichum peltatum, *Swartz.*)
928. Anemia adiantifolia, *Swartz.*
929. A. Breuteliana, *Presl. l. c.* p. 90. (A. Mandioccana, *Hook. Gen. Fil.* t. 90.)
930. Ophioglossum vulgatum, *L.* (Ophioglossum reticulatum, *L.*)

Dr. J. D. Hooker in the Flora of New Zealand unites all the species of Ophioglossum proper, and Sir W. J. Hooker, in his and Dr. Arnott's Flora of Great Britain, says he is ready to acknowledge the correctness of this view.

931. Psilotum triquetrum, *Swartz.*
932. Lycopodium cernuum, *L.*
933. L. reflexum, *Swartz; Hook. in litt.*
934. L. linifolium, *L.*
935. L. verticillatum, *L.*
937. L. taxifolium, *Swartz.*
938, 939 & 940. Species of Selaginella.

ART. XXIV.—*Some observations on the Motions of certain Winding Plants;* by WM. H. BREWER, Prof. of Chemistry in Washington College, Pa.

IT has long been recognized as a general law, that green plants during their growth grow towards the light, but all the botanical works that have come under my observation, which speak of winding plants and tendrils in this connection, speak of them as forming, practically, an exception to this law, that is, that they turn towards some "*dark*" or "opaque" object. That they do turn towards a solid support has long been observed, the fact is undisputed, and the cause of this motion, instinctive as it were, towards some solid around which they may twine has always been given, directly or inferentially as the absence of light, or more properly the opacity or non-luminous character of the support. I have been unable to find any account of experiments on this property of certain plants or of certain organs of plants further than merely to show the fact, that it exists.

During the summer of 1855 I made some observations on the growth of a hop vine (*Humulus*) to ascertain more precisely the relations between the rate of growth at different hours of the day, and the temperature, clearness and other atmospheric conditions. To effect this the vine was measured at stated hours several times each day, and the better to do this it was not allowed to wind around, but was trained up one side of a smooth pole. Incidental to the desired observations, it was noticed that during the heat of the day, although the plant sometimes grew several inches, it grew towards the light with only a very slight tendency to wind around the pole, while during the night, or on cold days, while the rate of growth was slower it would assume the spiral and cling closely to the support. On one occasion, when a number of plants were only from one to two feet high, a slight fall of snow took place which remained a day or more, and in a few hours, all the plants which had sprung up from the ground and remained perfectly erect until this time, inclined at a high angle towards a lattice which was artificially heated.

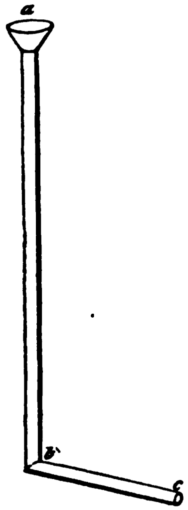
It was also found that they would climb a transparent glass tube almost or quite as readily as an opaque stick. These and similar observations at other times suggested to me that the cause of the motion towards a support was not owing to any influence of light, or its absence, but rather to *heat*, and to elucidate this subject a series of experiments were made at Ovid, N. Y., during the last summer.

These consisted in the main of presenting a warm and a cold support to some winding plant, and then observing if it manifested any preference. The plants experimented on were the

[redacted]

common Lima bean (*Phaseolus lunatus* L.) and the common morning glory, (*Convolvulus purpureus* L.) The general plan was to keep the plants in a closed room during the day and early part of the evening, where the air could be kept at a rather high and nearly constant temperature, and then remove them for the night into another room where the temperature was several degrees lower than the first, where the warm and cold supports were presented to them. This room was also closed and darkened that neither currents of air nor morning light should interfere with the accuracy of the experiments.

1.



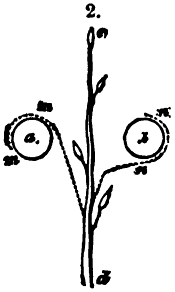
For the supports tin tubes were used, of the shape given in the figure, having a funnel *a*, at the top, and an elbow *b*, at the bottom, forming an obtuse angle. These were about an inch in diameter, similar in size and shape, and the vertical part painted black. These could be kept cool by filling with cold water, and if desired by placing ice in the funnel *a*, and could be warmed and kept at any desired temperature higher than the air, by a small spirit lamp placed under the end *c*. For the use of glass and other materials, an elbow of tin was employed, and then the straight tubes fitted with a cork. To test the effect of colors, tin tubes were painted of various colors, and in some cases colored paper was pasted around them. White, black, red, pink, green, blue, and yellow, were tried. When in use the tubes were held in a nearly vertical position, about five inches apart, one filled with well-water a few degrees colder than the surrounding air, the other filled with warm water and kept heated to any desired temperature by a spirit lamp, generally from 5° to 12° Fahr., above the temperature of the air in the room. The plant was placed at the beginning of the experiment so as to be midway between the two tubes, not exactly parallel with them, but crossing their plane at a low angle. It was allowed to remain without disturbance from 9 P. M. until 7 A. M., and its position, the temperature of the air and the water in the tubes and other conditions accurately noted at the beginning and close of each experiment.

Many preliminary experiments were made to devise means to avoid the various causes of interference, and to test and perfect the apparatus, and they so far succeeded that I consider the results given as reliable. After these, a series of fifty-two experiments were carefully made, of which nineteen were with Convolvulus, and twenty-three with Phaseolus. These gave in thirty-six cases results confirmatory, that is, the vines turned to

or towards the warmed tube, in fourteen cases they showed no especial preference, and in only two cases did they turn to the cold tube. In these fifty-two experiments, the right tube was heated twenty-five times, and the results were nineteen confirmatory and six indifferent; the left tube twenty-seven times, and the results seventeen confirmatory, eight indifferent and two contradictory, (that is, turned to the cold tube). In both of these latter cases the nights were exceedingly hot (one was 84° F.) and the experiments were in a room in which the sun had shown a part of the day and the walls had become heated, so that on closing the room the temperature rose during the night several degrees; the heat radiated from the walls doubtless effected the results. During the cooler nights, or when the temperature was below 65° F., the results were most marked, and generally in the morning the point of the vine, left the evening before midway between the two tubes, would be found not only moved towards the heated tube but would be closely twining around it, the point of growth lying closely against the surface. The right and left tubes were in turn heated on alternate nights and also they were made to exchange places occasionally. As both of the plants experimented on wind to the left, (the right according to Bischof) it will be readily seen that it makes much difference which tube is heated, when the plant is placed in the position relative to them which I have described, in the form the spirals will assume.

Thus, let *a* and *b* be the sections of the two tubes, and *c* the extremity of the plant *c d*, at the beginning of the experiment. Then if *a* be heated (the one I have assumed as the left tube in the description) the plant will gradually assume the position of the dotted line *m m*, by simply turning to the left. If however, the right tube, *b*, be heated, the plant will take the direction of the dotted line *n n*, by first rising vertical and then passing behind and around the tube.

2.



The room in which all the experiments (with the tubes) were conducted had but one window, opening west, which at night was carefully closed and darkened. In half an hour, sometimes in a few minutes, after the light had been admitted in the morning, the growing point of the vine would slightly relax the hold with which it would press against the support, and then during the day its growth would be towards the light. During this period, the tendency to grow in the direction of the light was vastly greater towards the warmed tube; in fact, the Phaseolus seemed to be entirely insensible to the latter during this time, and the Convolvulus nearly so.

I found that the Phaseolus, if grown in a room in which the temperature was high and nearly constant, not falling more than 3° or 4° F. during the night, would wind about a support in such very long loose spirals that it could not retain its position, but would slide down from time to time, and this same plant, when allowed the influence of cooler nights, would then wind in shorter spirals and cling with its accustomed tenacity to the smooth stick which served as a support. Furthermore, I found that by placing a plant in such a position that the sun could shine on its growing extremity, but not on its support, and changing it occasionally to keep up the conditions, turning it so that its tendency to grow towards the light was in opposition to that of its winding, and then keeping it at night at nearly the same temperature that it had during the day, I could entice it entirely away from the support until a length of several feet of the vine was pendant and unsupported.

These indicate the same fact sustained by the experiments with the tubes, viz., that plants wind best when the support is warmer than the air. This condition is fulfilled in nature at night, as the solid absorbs the sun's rays by day and cools more slowly than the surrounding air by night. I am aware that such plants will wind in nature around cold supports, such as growing plants of other species, but I doubt if their first direction towards them, before the contact is more than accidental.

There appears to be much difference in the force with which different species of winding plants assume the spiral. The Convolvulus seemed much more sensitive to the influence of heat than the Phaseolus, before it was in contact with anything, and much more independent of it afterward, for when once in contact with a support it could not be induced to again leave it, and would follow a piece of twine or slender rod apparently as readily as a more solid material. Many experiments seemed to indicate that *contact* with the support modifies the force with which plants assume the spiral, that in fact, although the fibres of the plant are somewhat spiral about its axis before contact, afterwards, these spirals are shorter, and only then will the whole plant assume a spiral form as if to enclose something in its turns.

This was beautifully shown by introducing the end of a vine into a thin glass tube at night; the fibres of the plant would assume a shorter spiral and sometimes the plant itself would wind around on the inner surface of the tube in the same form and direction as if it had enclosed some cylinder in its turns, while plants not so treated would remain nearly straight and their fibres less spiral.

The experiments with tubes of various colors gave no results materially different from the others.

These experiments were more striking than was anticipated, but were prosecuted under difficulties which prevented their being completed.

They are intended as the preliminaries to more extended and complete investigations in the same direction, to be continued at some future time, embracing the interesting question, whether tendrils are influenced by the same causes and follow the same law, also some things relating to the direction of winding plants, the length of their spirals compared with their diameter, the direction of the spiral growth of various trees, &c. Some observations have already been made on all of these subjects except that of tendrils.

The experiments performed, indicate, I think,

1st. That during the day winding plants like others grow towards the light.

2d. That they possess the property of turning towards some solid support.

3d. That this is more manifest by night than by day, and the most so on cool nights following hot days.

4th. That this is not controlled by any influence of light or its absence, exerted by the support.

5th. That heat is the controlling cause, and that such plants will only turn (unless it be accidentally) towards a support, the temperature of which is higher than that of the surrounding air.

6th. That the color and material of the support exert no influence further than that they influence the radiation and absorption of heat; and

7th. That when such plants are in actual contact with some support, the tendency to wind spirally around it is much greater than they manifested in order to reach it.

Art. XXV.—*On some Anomalies in the Florida Gulf Stream, and on their further Investigation;* by Lieut. E. B. Hunt, Corps of Engineers, U. S. A.

(Read before the American Association for the Advancement of Science, at the Baltimore Meeting, May, 1858.)

There is perhaps no portion of the ocean waters which has been so imperfectly studied, in proportion to its importance, as that from the west end of Cuba through the Gulf of Florida. The whole commerce of the Gulf of Mexico is directly concerned in whatever investigations shall more accurately define the currents or other physical peculiarities of that portion of the Gulf Stream area from the line joining Cape Antonio to Cape Catoche, and the latter with the Tortugas, thence to the eastward through that grand channel bounded on the north and

west by the Florida Reef and mainland, and on the south and east by Cuba and the Bahama banks. As it is the natural outlet for the products of the entire gulf coast and of the valley of the Mississippi, the present commerce following this route, vast as it is, must ultimately be so far exceeded, that it will seem almost insignificant in comparison with that which another half century will direct through this channel. The character of this navigation, no less than its amount, is such as to demand the most careful study of the currents, by which it is so largely influenced. All are so familiar with the immense annual losses to commerce by wrecks and disasters on the Florida Reefs and Bahama Banks, that a simple reference to the fact will abundantly vindicate the importance of carefully gathering whatever knowledge can give greater safety to this navigation. The high extra premiums for marine insurance by this Florida channel route, afford another striking testimony to the risks of this navigation; but I think it right to remark here, that, from the best information I could obtain at Key West, the Florida channel insurance rates are very much too high, and are annually giving exorbitant profits to the insurance companies. This makes it the interest of these companies to exaggerate the dangers of this passage; and it is believed that they are, on this account, less averse to wrecks, and less strict in distinguishing collusive or fraudulent wrecks than they should be. A reduction of rates must soon be made, if we may judge from the fact that owners are, to a considerable extent, becoming their own insurers, in preference to paying the established rates. The new light-houses and coast-survey beacons have added much to the security of this route, and the business of wrecking at Key West is, on the whole, diminishing, although commerce is of course increasing. Making all due abatement for the exaggerations of the terrors of the Florida Straits, and for the increased aids to navigation, there still remains a very serious annual marine loss, due almost entirely to the imperfect acquaintance of navigators with the peculiarities of the route, and especially with the currents. Misled by false or imperfect views about the Gulf Stream, and other currents prevailing here, sea captains are frequently so unfortunate as to run directly on the reefs, while they suppose they are well out in the channel way. I cannot but think that a system of reef pilotage, properly organized and well conducted, would lead to a great reduction in the number of casualties. By taking and leaving well-trained pilots at the entrance to, and exit from, the region of danger, the numerous casualties due to the imperfect knowledge of sea captains would be in great part obviated. Skillful pilots, constantly engaged in taking vessels through the channel, would grow more and more certain of all the essentials for secure passages, until it would become a gross

offence to lose a vessel, except from causes truly extraordinary. It is obvious that such pilots should be so situated that no possible advantage could accrue to them in case of wreck, while a premium should be awarded for each safe pilotage. Were such a system in full operation, it would be a proper rule that a vessel failing to take a reef pilot should forfeit its insurance, except when no pilot could be procured. A great difficulty in accomplishing this plan except by the combined action of the insurance companies, is found in the fact that three national jurisdictions enter the field of pilotage.

A first essential for giving greater security to the Florida channel navigation is a more correct determination of the currents by which vessels are affected during the transit. Having spent the last winter at Key West, I was led to inquire about these currents with some particularity, and, as a result, was brought to the opinion that the prevalent views are very seriously at fault. There are many facts quite incompatible with the common notions of a vast current constantly sweeping around the Gulf of Mexico, and thence pouring in full volume through the Gulf of Florida. I will here cite some notes of testimony given me by various persons specially acquainted with the matters in view. They were questioned more particularly with reference to facts and opinions touching a southwesterly current prevailing more or less between the easterly Gulf Stream and the Florida reef. Such a counter or eddy current is definitely indicated on Jeffrey's map of 1794, by a dotted line, above which is written, "North of this line is a current setting southwestward, unless when the wind is at north or east, which winds admit of no southwest;" and, "South of this line the current of the Florida stream sets always northwardly."

Capt. Geiger, who for over thirty years has been observing the waters of this vicinity, most of that time having acted as a pilot off Key West harbor, and who is perhaps better acquainted than any other person with the currents there prevailing, gives the following statement of facts.

A strong north or northeast wind keeps the Gulf Stream back, and makes a westerly current near the shore. During June, July, and August, the westerly current prevails more than the easterly current from five to fifteen miles from the reef. The direction of the current depends mostly on the wind. The westerly current prevails for from one third to two fifths the entire time from year to year, for from two to fifteen miles outside the reef off Key West. He has known it twenty-five to thirty miles off Sand Key. When the Gulf Stream is strongest on the Cuba shore, the westerly current is strongest on the north side; and when it is weakest along the Cuban shore, the Gulf Stream sets close along the reef. He has found the westerly current as

far up as Carysfort, but not frequently, and not broad or strong. This current broadens from Carysfort to the westward, and continues about constant along its course. The tides on the two sides of the reef are about six hours apart, on an average; but set, on the whole, as much one way as the other over the reef. Sometimes there is a narrow easterly current for a mile from the reef; then a westerly current, and then the Gulf Stream. Both the United States steamers Susquehanna and Wabash were set westwardly by the current about eight or ten miles during the past season. A considerable number of the Gulf traders know of the westerly current, and make more or less use of it in navigating westwardly. When running with the wind the water is smooth, and rough when running against it. After northers, the westerly current is to be expected. Sometimes, in crossing to Havana, no Gulf Stream indications are found; and sometimes a westerly current is found along the north shore of Cuba. Notwithstanding Capt. Geiger's long observation of these currents, he says that he is quite unable to reduce them to rule, or in any way to know before hand how the current will be found to set. He asserts that the Gulf Stream sets from the vicinity of Cape St. Antonio, northeasterly through the Florida channel, and that the main stream does not make the circuit of the Gulf of Mexico as generally supposed.

Captain Richardson, pilot of the Coast Survey surveying steamer Corwin, says, in substance, as follows: The westerly current appears irregularly chiefly in the winter, but sometimes during the prevalence of the regular trades. It extends from ten to fifteen miles off from Sand Key, sometimes running as much as two miles an hour. It never prevails over the reef proper. It sets for two months or so some winters. It spreads farther from the reef as it goes west. Has known it as far north as Carysfort, just outside the reef, and at Cape Florida even where the reef is narrow and deep, this current sometimes sets across it some two miles from shore, but is not very frequently found there. As it runs west it seems to increase in breadth. Off Indian Key he has known it to extend seven miles from the edge of the reef; at Bahia Honda it is sometimes ten miles, and at Sand Key, from ten to fifteen miles. In the winter of 1856–7 there was very little of this current. In crossing from Key West to Havana the Gulf Stream runs much stronger on the Cuban side. To some extent, navigators know this westerly current, and use it with great advantage when bound west. In one case in 1852 he knew of two vessels bound east past Tortugas which separated about 100 miles in twenty-four hours, by one captain knowing this current and the channel, while the other kept in the westerly current. The tide between the Quicksands and Tortugas sets flood N.N.E. and ebb S.S.E., differing from the charts.

Captain Wilson who has for several years been running on the vessel serving Fort Jefferson on Tortugas as a mail boat to and from Key West, says that for some three months prior to Feb. 11, 1857, there was a strong and decided westerly current on the north margin of the gulf, on the reef between Key West and Tortugas. It had then for some two months been constantly to the west. Running out from Tortugas on an E.S.E. or S.E. course, and tacking to the north or east of north when the point was reached, which in an ordinary gulf stream would bring him out somewhere from Sand Key light to six or seven miles west of it, which tack if there were no currents would bring him out abreast the Marquesas, he has six times in the last three months come out abreast the Quicksands, thus falling short of where he would have been had the water been still, by some eighteen to twenty miles, or some thirty miles west of Sand Key where he would have fetched during a full Gulf Stream current. It usually takes about twenty hours to run both branches of this tack. There is no appearance of any current on or within the reef either way except the set of the tides. When the westerly current is running, he finds it better to beat up within the reef than to attempt to cross over into the Gulf Stream. Mr. W. thinks the current sometimes extends half way across to Cuba. He says, this westerly current has prevailed more or less, every winter for seven years that he has been running between Key West and the Tortugas; but never so strong as this winter (1857–8), or for so long a time, probably not over a month in any previous case. He thinks the westerly current mainly disappears during the prevalence of the regular summer trades.

I was informed by General Totten that Com. Bainbridge told him, that in a voyage made by him some fifty years since, when he supposed himself in the Gulf Stream, west of Cape Florida, he found by known landmarks that he had drifted a considerable distance to the westward instead of to the eastward.

I am indebted to Mr. Charles Tift, of Key West, for the following notes:—

"In December, 1856 (I think), the barque Joseph Hale from Philadelphia for New Orleans, got ashore ten miles southeast from Cape Florida light-house. She had passed round the 'Isaacs,' and made the Orange Keys, steering for the Double-headed Shot Key's light. While looking out for the light, the ship apparently going seven knots, she struck, and proved to be in the position above stated.

"The ship Rockland from New Orleans to Boston was off the Pan of Matanzas at four o'clock (say March 25th, 1858), wind E.S.E., ship going per compass E.N.E., intending to sight Double-headed Shot Key light. At twelve o'clock saw what was supposed to be the light on Double-headed Shot Keys, and kept the

ship off to pass it on the gulf or western side. But the light proved to be the new one on Sombrero Shoal (just opposite), of which the captain had no notice, and she struck a shoal inside the main reef. A glance at the chart will show how far these captains were mistaken in their estimate of both the force and direction of the current.

"Some years since a fishing smack left Key West to go to Cape Florida. The wind was eastwardly, and after she had beaten to windward for some forty-eight hours, she stood in to make the land. She fetched twenty miles to the westward of the starting point, showing in this instance, a strong westerly current from the centre of the Gulf."

Mr. Tift adds that he "knows that the 'gulf current' sometimes, though rarely, runs strong to the eastward a mile or more *inside* of the reef (at Key West), but that the general set is westward for a *short* distance from the main reef." The idea, however, of a "strong westerly current" on this "edge," must be taken with many grains of allowance. A ship-master leaving the strong gulf current and approaching the margin, finds the set so reduced in its rapidity as to conclude that he has found the stream actually going westward. As stated above, this is only true to a very limited extent, or in other words the belt of westwardly current is very narrow.

I am indebted to Mr. Baldwin, collector at Key West, for a case in his own experience showing a westerly drift, and for some observations made specially valuable by his long and full acquaintance, not only with the matters in question, but with the navigators frequenting Key West.

In June, a few years since, Mr. B. made a passage in a fast-sailing brig from Mexico to Havana. After leaving Campeachy Bank, they made Tortugas Islands and took a departure about sunset, steering about southeast by east. About midnight it fell calm, and for five days they experienced only calms and occasional light airs from the south. On the sixth day there was a light wind from the east. The master, an experienced navigator and well acquainted with those waters, steered south, supposing he had drifted through the Gulf. On the morning of the seventh day he made land, which he supposed was somewhere near Matanzas, but which turned out to be near the Colorados, a reef off the west end of Cuba.

Again, in a voyage from St. Marks to Key West, Mr. Baldwin says, that being set by strong southwest currents in the Bay of Mexico, they fell to leeward and made the Tortugas Islands. Having an experienced pilot they ran through into the gulf between the Tortugas and the Quicksands. After beating to windward for three days they stood in, and found themselves six miles to leeward of where they entered the gulf. Satisfied that

they had to contend with a strong westerly current, the master consented to beat up inside the reef, and they reached Key West in thirty-six hours.

Mr. Baldwin says he has conversed with many intelligent ship-masters, with the Key West pilots, and with the masters of fishing smacks who are constantly crossing and recrossing the gulf to and from Cuba, and says that they assure him that no dependence can be placed on the Gulf Stream; sometimes it runs very much stronger than at other times in a northeast direction: that it very frequently runs in a southwest direction; and that at other times there is no current at all. Very frequently they experience an easterly current on the Cuba coast and the reverse on the Florida coast, and at other times a strong current in the centre. The current cannot be mistaken, as the change is perceptible to the eye.

Mr. Baldwin adds, "A great deal depends on the force of the wind. My own observation has satisfied me that the wind influences the set of the Gulf Stream; for instance, after a heavy northeast wind the stream sets to the northeast at a very rapid rate, and *vice versa.* Since my residence at Key West, I have known several vessels to be brought in from the northwest, having got into the Bay of Mexico, when supposing themselves east of Cape Florida."

He was assured by the master of a vessel from Honduras, and another from Central America, both stranded, that they had come round Cape Antonio, and after beating as they supposed in the gulf, aided by the Gulf Stream for a number of days, discovered land, and judging it to be the Bahamas, shaped their course through the gulf, and were stranded near the Cedar Keys.

These scraps of testimony might be much extended if necessary, but I suppose they fully suffice to show that we are still very far from possessing the knowledge the case demands. They clearly prove that there is enough westerly current in the Gulf of Florida to be of vast importance to navigation if its movements can be defined, and to constitute a great danger, if it is not known. Its variations are also well established, and should be known to navigators. I am also quite well persuaded, not only from actual testimonies, but from the fact that a coral bank extends above Cape Catoche, that at least a large part of the Gulf Stream turns to the northeast around the west end of Cuba, instead of making the circuit of the Gulf of Mexico. The effect of the earth's rotation, and of its own inertia, on the current coming north from the Caribbean Sea, would be to give it an eastward bend. It is also quite incompatible with the tendency of the westerly current to expand towards Tortugas, to suppose that the main Gulf Stream comes sweeping in from near the mouth of the Misissippi towards this point.

Before attempting to theorize on the cause of this westerly current, it is certainly very desirable that it should be more accurately defined. The effect of dragging by the Gulf Stream along its sides, may perhaps be to produce a deficiency of water behind, to be replaced by a return current of this degree of force, but it would certainly not call for such a vast body of westerly current as is vouched for in some cases, nor would it explain its alleged fluctuations. Some of the wrecks which have lately occurred seem due to a strong current setting through the Santarem Channel, and we may see in this a suggestion of a cause for the westward currents when these exceed the magnitude of a proper eddy. A Santarem current projected across the gulf, may be thrown down the reef, though I should not much expect such a result.

It will be well here to call attention to the refutation of the theory that the Gulf Stream owes its progress to a declivity resulting from heaping up waters in the Gulf of Mexico, which this parallel counter current affords. There is no evidence of any such elevation of the Gulf of Mexico as this theory calls for. On the contrary there is no such southeast current across from the Bay of Mexico, Barnes's Sound, &c.,—as such an elevation would inevitably create. The whole motion of a descending river in the sea, with its source in the Gulf of Mexico, seems to me quite untenable and conflicting with facts.

The natural conclusion from what has preceded is, that there is abundant need of further exploration into the movements of this whole system of currents. Their incalculable commercial importance makes such an inquiry any thing but speculative, and should stimulate active and well-conditioned observations. We well know how imperfect the observations by the drift of ships must be; they are rather indications than measurements.

In view of the present state of the case, I would ask attention to the promise of results offered by undertaking an extensive series of current bottle observations; on the line from Cape St. Antonio to Cape Catoche. By systematic proceedings several points might be well illustrated. Suppose a vessel to cross on this line, say twice monthly for a year, throwing over one or two hundred bottles each time, containing slips duly numbered so as to indicate each starting point accurately; these points being regularly distributed on the line run, and checked by the verification of the route sailed. As these bottles proceed on their course, they will become faithful witnesses of the currents, and by their spreading they will show conclusively what the real course of the Gulf Stream is, and whether it is broken, one branch sweeping around the gulf coast, and the other pushing

on northeasterly. With a view to promote their being readily picked up at sea, I would propose that flasks of white glass, blown with broad bases, should be used. These could be seen at a distance, and in a region so crowded with sails as the Gulf of Florida, very many would be picked up while still afloat, thus giving a true measure of mean velocity. A small sailing vessel, such as one of the Key West pilot boats, or the revenue cutter at that station, might, by having a good observer put aboard, make such a course of observations with slight expense in proportion to the results. It is hardly needful that I should here further state the bearings of such a plan, but I think all will concede to it the promise of elucidating some important questions of the Gulf currents. It would surely be much better, could deep sea observations be made also, and to some extent probably they might be connected with a current bottle campaign. The superficial study, ought certainly not to be longer deferred; after this, we can take a next step more wisely.

ART. XXVI.—*Abstract of a Meteorological Journal, kept at Marietta, Ohio:* lat. 39°·25 N. and lon. 4°·28 W. of Washington City; by S. P. HILDRETH, M.D.

MONTHS.	THERMOMETER.			Fair days.	Cloudy days.	Inches of rain and melted snow.	Prevailing Winds.	BAROMETER.		
	Mean temperature.	Maximum.	Minimum.					Maximum.	Minimum.	Range.
January, . . .	40°·44	67	22	12	19	1·66	W., S.W., & E.	29·93	28·95	0·98
February, . . .	28·00	60	−5	11	17	3·41	W., N.W.	29·75	28·90	0·85
March, . . .	40·70	75	0	21	10	1·00	W., N.W., & S.	29·63	28·95	0·68
April, . . .	54·70	78	26	12	18	5·00	W., S.W., & E.	29·63	28·70	0·93
May, ...	60·70	84	42	7	24	12·42	S., S.W., & E.	29·65	28·80	0·85
June, ...	72·70	99	48	20	10	3·09	S., S.W., & S.E.	29·60	29·00	0·60
July, ...	75·20	95	57	19	12	5·33	S., S.W., & W.	29·63	29·20	0·43
August, . . .	72·13	95	48	19	12	7·42	S., S.W., & W.	29·60	29·15	0·45
September, . .	64·33	91	38	23	7	1·37	S.W., S., & E.	29·80	29·15	0·65
October, . . .	56·66	85	38	13	18	7·66	S.W., N., & E.	29·80	29·10	0·70
November, . . .	38·80	63	20	3	27	4·82	W., N. W., & S.	29·70	28·85	0·85
December, . . .	40·64	63	14	10	21	8·66	S., S.E., & E.	29·90	29·05	0·85
Year, . . .	53·75			170	195	61·84				

Temperature.—The mean temperature of the year 1858 is 53°·75; more than two degrees above that of 1857, which was 51°·43. The extremes of heat and cold have not been so great as in some years, especially that of cold; the lowest grade of

the thermometer being only five degrees below zero, in February.

Rain and melted snow.—The amount of rain and melted snow is sixty-one inches and eighty-four hundredths, a quantity somewhat exceeding that of any other year since I have kept a register, thirty-two years, and with that kept by Mr. Wood from 1818, making forty years; forty-two inches is the mean amount for a series of years, but in dry periods it sinks sometimes to thirty-two inches, about half that of the past year. The month of May exceeded in quantity that of any other, being nearly twelve and a half inches. It was divided among the seasons as follows: winter $13\frac{73}{100}$ inches, spring $18\frac{42}{100}$ inches, summer $15\frac{84}{100}$ inches, autumn $13\frac{85}{100}$ inches. The quantity of snow was small, four inches being the greatest depth at any one time, not affording sufficient for sleighing.

Winter.—The winter of 1858, was uncommonly mild, the mean being 36°·54; more than six degrees above that of 1857, which was 30°·35; while that of 1856 was 25°·50, the lowest of any one on record. The moderate weather continued until near the middle of February, about which time the Ohio river was open and navigable for steamboats. The mean for December was 41°·20, and that of January 40°·44, being many degrees above that mean for these months, so mild was the weather that it was feared we should have no ice for summer use. The buds of fruit trees swelled as they do in March, and some peach trees on a high sandy ridge of land in Noble county, fifteen or twenty miles north of Marietta, opened their blossoms on the 28th day of January, and what is very curious, notwithstanding the cold in February and March, produced fruit. It was as late as the 18th of February before navigation was closed by ice, and the 24th before the Ohio was frozen over. It remained shut only a few days, and boats were again running by the tenth of March. In a majority of years, the Ohio is closed for a short time in December, but invariably opens again at or near the winter solstice, when there is commonly an abundance of rain. February was a cold month, the mean being 28°·00; whereas in 1857 it was 42°·73, a difference of nearly fifteen degrees. The earlier part of the winter was mild all over the valley of the Ohio.

Spring.—The mean temperature of the spring months is 52°·03; being nearly seven degrees above that of 1857, and a full medium for this climate, the difference being occasioned by the higher temperature of April. The mean of this month is considered as usually representing that of the year, but in 1858 was nearly three degrees above it. The month of May was about the ordinary temperature 60°·70. The early part of March was uncommonly cold, the mercury falling to zero on the seventh of

the month, and for a number of days it was but a little above that point. This severe cold had a disastrous effect on fruit trees of all kinds, especially peaches, apples and pears, the crop of these varieties being entirely destroyed all over the Western States, except in a few favored places, especially in orchards located on the tops of high ridges with a light loamy soil; at this time the blossom buds were red, on the point of opening their flowers. Orchards on islands in the Ohio river were in some measure protected by the proximity of water, and produced a partial crop. The loss to the country must have been more than a million of dollars, as there is scarcely a farmer in the land who has not more or less acres of orcharding, some along the borders of the Ohio raising in ordinary years two or three thousand barrels of apples. Fruit trees blossomed at about their usual period, and when in this state, a severe frost on the 27th of April destroyed the remaining strength of the germs, so entirely that the young fruit all dropped off before it attained the size of a robbin's egg. The grape being later in blossoming, escaped in a measure the ill-effects of frost; but the excessively wet summer rotted and mildewed a large portion of the fruit, disappointing the hopes of the cultivators in affording them only a small crop.

The month of May was excessively wet, raining more or less copiously on seventeen days, summing up at the end of the month the enormous quantity of twelve and a half inches, which is more than all that fell in the spring months of 1857, and a greater amount than ever known before since a register of the rain has been kept. For the three spring months this year the amount was eighteen and a half inches. The effects of this superabundant and constant wet, was very disheartening to the cultivators of the soil. The land could not be plowed at the proper time for the planting of corn and other spring crops, and when it was done, the seed rotted in the earth. Along the margins of the creeks and rivers the bottoms were overflowed, destroying the seeds that had already germinated, and leaving much drift and rubbish, thus marring the grounds for future cultivation. These overflows continued to recur, until as late as the fifteenth of June, and many fields were replanted two or three times, while others were abandoned as hopeless. This excess of rain was not confined to the State of Ohio, but was felt in all the Western States, especially on the river Wabash, where the floods in June were very disastrous. West of the Mississippi river the rains were still more copious, as by a notice in a letter from Lee County, Iowa, there had fallen sixty-five inches from the eighth of April to the first of November, the usual quantity being only forty-four inches; and as December was a very wet month, there was not less than seventy-two inches, or six

feet during the year; an amount usually found only in tropical climates.

Summer.—The mean temperature of the summer months is 73°·34, one degree more than in 1857, and a full average for this region. For the healthy growth of plants there was abundant heat; but the excessive rains so saturated the earth that their roots were in a manner drowned, especially on flat lands, causing a sickly aspect, instead of the usual deep green color seen in common seasons. There was a large proportion of straw in the wheat and oats, but a lack of fullness in the grain; much of the wheat being shriveled and light, a blight or rust having attacked the stems a short time before the harvest, so that in the operation of threshing, a cloud of offensive ill-flavored dust annoyed the workmen, making this labor very irksome. This mould, on the oat crop was still more destructive, causing a total failure in three-fourths of all the fields in the valley of the Ohio; such as escaped were on high grounds and sowed very early. Many fields of wheat were not reaped at all, and left to decay on the grounds, or plowed in for the next crop.

The weather being warm all through the summer and till late in the autumn, gave the Indian corn time to perfect its growth and ripen the grain before the setting in of frosts, thus saving the inhabitants of the west from the disastrous effects of a famine. The grain of this plant, a native of America, is above all others suited to this climate; affording the most nutritious food for man and beast. Potatoes, next to maize as a food for the laboring man, were also a failure. The rot so disastrous in its effects a few years ago to Ireland, destroyed this desirable esculent after it was nearly full grown; and thousands of acres in the southern portions of Ohio, hardly returned the amount of the seed that was planted. Sweet potatoes fared much better, and yielded a fair return to the cultivator. Being a native of a tropical climate, heat and moisture do not injure it if planted on a sandy soil. This year the price of this valuable root was less than that of the common potatoe, when in ordinary years it is double that article. The amount of rain in the summer months was nearly sixteen inches. The maximum heat 99° on the 29th day of June. Although wet summers are accounted to be sickly, yet no epidemic fevers prevailed; it was very healthy.

Autumn.—For the autumnal months the mean temperature is 53°·26, varying but little from that of 1859. During September and October there was no destructive frost, nor until the middle of November, giving late planted corn time to ripen, which it had fully accomplished by the last of October. In ordinary years this crop is ready to be cut by the twentieth of Sep-

tember if planted in due season; all over the uplands of the State it was unusually fine, better on the hills than on the bottoms, as the latter had been too wet for a healthy growth. This abundance of corn furnished the farmers with the means of better fattening their hogs than last year, and the yield of pork is much greater and better in quality. It also bears a fair price, enabling them in some measure, to make up for the loss of their wheat and potatoes. It has been on the whole a disastrous year for the agriculturist, and pecuniary affairs were never more depressed than at present, even more so than in the panic and mercantile failures of 1857, as then he had a fine crop of wheat and abundance of fruit and potatoes to comfort him under his losses.

On the 27th of November there fell seven inches of snow with the temperature at 33°. It rained the following night and in forty-eight hours it was all melted. There has been no ice in the rivers up to this time, 5th of January, 1859, and the greatest degree of cold, the 9th and 10th of December, is 14° above zero.

Floral Calendar.—March 12th, Bluebird seen; ·17th, Robbins appear; 20th, Blackbirds in flocks; 25th, Primroses opening, Sugar tree in blow; 29th, Daffodill; 30th, Hepatica triloba, Crown Imperial 12 inches high. April 3d, Crown Imperial open; 4th, Early Hyacinth; 5th, Golden bell or Forsythia virida; 6th, Magnolia conspicua, most of the blossom buds killed in February; 7th, Peach tree, in sheltered localities; 9th, Pear tree opening; 10th, Sanguinaria Canadensis, Pyrus Japonica, a few blossoms, much injured by the cold 23d Feb.; 11th, Pear in bloom; 12th, Spiræa prunifolia, blooms sparingly, much killed by the cold, Double flowering peach, very fine, more hardy than the common; 13th, Cercis Canadensis, or red bud; 14th, Plum and Cherry; 15th, Cucullaria spectabilis; 17th, Apple in full bloom; 18th, Jeffersonia diphylla; 21st, Dwarf Ranunculus Triphyllum uliginosum; 24th, Lilac; 26th, Cornus Florida; 29th, Quercus tinctoria, black oak; 80th, Garden tulip and tree Peony. May 3d, Viburnum dentatum, black Haw; 8th, Prunus scrotina, black Cherry, Cratægus flava, summer Haw, Shell-bark hickory, Aquiliegia Canadensis, Columbine; 9th, Geranium maculatum; 13th, Robinia pseudoacacia, yellow Locust, Dodecatheon Illinoisi, or Prairie Captain, Calceolaria, white and yellow varieties; 13th, Weigelia rosea; 18th, Magnolia tripetala, Castanea equinus, Horse chestnut, Rubus villosus, Blackberry, bore an enormous crop of fruit, more than ever known before; 19th, yellow Harrison rose; 20th, Black mulberry; 22d, Purple peony; 23d, Syringa fragrans. June 2d, Euonymus atropurpurea, wahoos; 3d, Syringa Philadelphica; 4th, Trades-

canthia virginica, Spiderwort; 5th, Rosa Carolina, swamp rose; 8th, Sambucus Canadensis, Elder; 11th, Vitis cordifolia, frost grape; 12th, Rosa multiflora, prariensis; 13th, Triosteum perfoliatum, feverwort, Rhus typhina, sumach; 25th, Wheat harvest begins in warm exposures; 28th, Asclepias cornuti, milkweed. July 6th, Lobelia spicata; 15th, Rhus radicans, trumpet creeper; 16th, June-eating apple ripe; 17th, Sweet bough apple; 18th, Blackberry ripe; 26th, Cassia Marylandica, wild senna, in flower. August 11th, Watermelon ripe in open fields; 19th, Sweet potatoe in market, good size.

Marietta, Ohio, January 5th, 1859.

Art. XXVII.—*Remarks on the Lower Cretaceous beds of Kansas and Nebraska;* by F. B. Meek and F. V. Hayden.

(Extracted from the Proceedings Acad. Nat. Sci., Philad., Dec., 1858, with additions by the authors.)

The Cretaceous System as developed in Nebraska, is clearly divisible into five distinct formations, which have, for convenience, been numbered 1, 2, 3, &c., from the base upwards. Although at first entertaining some doubts as to whether No. 1, or the lowest formation, might not be older than Cretaceous, we always placed it provisionally, in our published sections, in the Cretaceous system. More recently, after a careful review of the subject, we became satisfied from the modern affinities of numerous dicotyledonous leaves found in this formation, that we hazarded little in regarding it as a settled question that it could not be older than Cretaceous, and so expressed ourselves in our paper read before the Academy of Natural Science, Philadelphia, March, 1858.

The references of this formation to the Cretaceous, however, was not without some exceptions generally admitted, for Professor Jules Marcou, in his work on the "Geology of North America," page 143, refers it to the New Red Sandstone, and in a subsequent publication* he places it in the Jurassic; while some investigators in this country also, inclined to the opinion that it must be Triassic. In the midst of these conflicting opinions, although satisfied we were right, we wished, in order to remove all doubts from the minds of others, to have the opinion of some good authority in fossil botany, (a department of palæontology to which we have given little attention,) respecting the fossil leaves on which we mainly based our views in regard to the age

* Notes pour servir a une description geologique des Montagnes Rocheuses, p. 20.

of this formation. Consequently, we sent outline sketches of a few of them to Professor Oswald Heer,* the distinguished authority in fossil botany at Zurich, Switzerland, informing him they were from a formation we regarded as Cretaceous, and requesting him to let us know to what genera and geological epoch he would refer them. This letter was sent to Professor Heer in August last, before we started to Kansas, and on our return, in the latter part of October, we were disappointed at finding no reply from him. After waiting some days longer, and receiving no answer from Professor Heer, we concluded our letter had either failed to reach him, or that he was unwilling to express an opinion based upon mere sketches of the leaves; consequently we submitted the whole to Dr. Newberry, who had then returned to Washington, and in whose opinions on this subject we have the fullest confidence.

After examining the specimens, Dr. Newberry gave us a written statement bearing date, Nov. 12, containing a list of the genera to which he had referred the leaves, together with some interesting remarks and generalizations, in which he expressed the opinion that they are certainly Cretaceous, some of them belonging to genera peculiar to that epoch, and that the whole belong to more highly organized plants than are known in the Triassic or Jurassic flora.

Knowing as we did that the rock from which these plants were obtained, beyond all doubt, holds a position beneath, at least, eight hundred feet of Cretaceous strata, containing great numbers of *Ammonites*, *Scpahites*, *Baculites*, &c., it of course never once occurred to us that any person might suppose it Tertiary.

About the thirteenth of November we sent on to the American Journal of Science, a communication containing Dr. Newberry's list of the genera to which he had referred these plants, with some extracts from his remarks, all of which appeared in the January number of that Journal.† Some two or three weeks after we had corrected the last proof of this paper, we received (13th of Dec.) a letter from Professor Heer, bearing date of Nov. 26, in which he informed us that our letter had reached him at a late date, in consequence of his absence from home, and that after his return, other engagements had prevented him from replying sooner. In this letter Professor Heer, in accordance with our request, sent us a list of the genera, as near as it was possible for him to make them out from hastily drawn sketches, and also kindly furnished brief diagnoses of the species, stating at the same time that although one of the outlines resembles a

* Our friend Dr. Newberry was then in New Mexico.

† These were published in the last number of this Journal.

Cretaceous genus (Credneria,) the nervation being obscure, and the others more like Tertiary forms than anything known in the Cretaceous of the old world, he was inclined to the opinion that they are Tertiary.

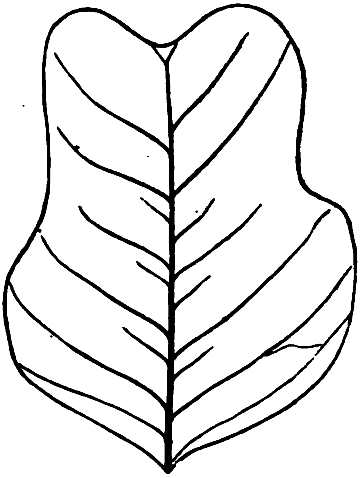
Along with Professor Heer's letter, we also received a printed pamphlet, entitled "*Letters on some points of the Geology of Texas, New Mexico, Kansas and Nebraska; addressed to Messrs. F. B. Meek and F. V. Hayden, by Jules Marcou.*" In this pamphlet Professor Marcou quotes Professor Heer's conclusions in regard to our fossil plants, and expresses the opinion that No. 1, of the Nebraska section, is both Miocene and Jurassic, or in other words, that we have included in it strata belonging to each of these two widely different geological epochs.

Having a very high regard for Professor Heer's opinions on any question in fossil botany, where he has had an opportunity to examine the specimens themselves, or to study good figures and descriptions, we are quite sure, had the whole collection been submitted to him, instead of mere sketches of a few of the species, his opinion would have been very different. At any rate we can assert, with the fullest confidence, that it is absolutely *impossible* that this formation, or any part of it, can be Tertiary, for we know it passes, as already stated, beneath at least eight hundred feet of Cretaceous strata. This is not mere conjecture, nor an inference drawn from having seen this formation under circumstances leading us to *suppose* from the dip of the strata, that it must pass beneath the Cretaceous if continued in a given direction at the same angle of inclination, but from the fact that it has actually been seen, directly beneath the other Cretaceous rocks, not merely at one place, and by one observer, but by several persons at numerous localities.

In order to satisfy others that we are not mistaken in this, we will give a few of the many facts in our possession, bearing on this question. In the first place, we would remark that the farthest point towards the south at which we have seen this formation, is near Smoky Hill river, in Kansas, latitude 38° 30′ north, and longitude 97° 30′ west. Here we found it forming the upper part of several isolated elevations known as the "Smoky Hills," at an altitude of about 1200 feet above the Missouri at Fort Leavenworth. At this locality, however, we saw no rocks overlying it, and consequently have no *stratigraphical* evidence that it is the same rock seen by us at other localities under Cretaceous beds; but our lithological and palæontological evidence is quite conclusive on this point, for this rock in color, composition, and all other respects, is undistinguishable from No. 1, of the Nebraska section, as seen near the mouth of Big Sioux river on the Missouri, and contains numerous fossil leaves, some of which are identical with those occurring in No. 1, at the last

mentioned localities. Amongst these leaves Dr. Newberry has also identified at least one genus (*Ettingshausinia*, No. 3 of the following cuts,) peculiar to the Cretaceous System. The specimens from which this outline was drawn, was not in our possession at the time we sent the outlines to Professor Heer, but was afterwards found associated with several of the species from which the sketches sent him were drawn. The annexed cuts, Nos. 1 and 2, represent other forms from the same rock.

1.

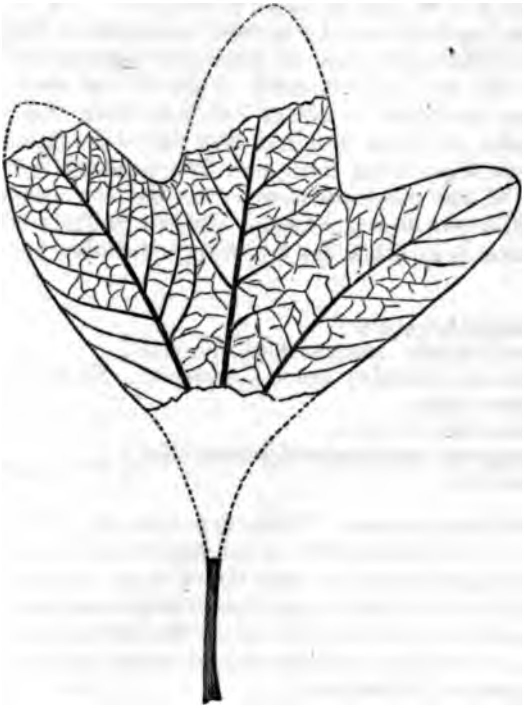


Bearing in mind that all the rocks here have a gentle but uniform inclination or dip to the northwest; and that the formation under consideration con-

2.

sists of red, yellowish, and other colored sandstones and clays, with generally more or less impure lignite and ferruginous concretions, we will be prepared to recognize it at lower and lower elevations as we proceed northward.

a.



Without undertaking to mention in detail all the intermediate places where this rock is known to occur, we pass at once to localities where it has been observed by various persons *beneath* Cretaceous beds. First at several points on the Republican fork of Kansas river, about eighty miles above its mouth, and some sixty miles nearly due north of the Smoky Hills, it was seen by Dr. H. Englemann at an elevation of about 1000 feet above the Missouri, at Fort Leavenworth. Here Dr. Englemann describes it as "a coarse grained, friable dark brown ferruginous sandstone, and very compact white and light colored shaly sandstone."

Near this locality he saw it *overlaid* by Cretaceous beds, the section given by him being as follows descending. "The top was formed of a white granular limestone, and another more impure yellowish variety *full of Inoceramus.* Below there seemed to be a sandy clay, probably from decomposition of arenaceous and argillaceous slates, and then a stratum of gray compact subcrystalline limestone in thin layers, *full of Inoceramus Cripsii.*

In the lower part of the hill the ferruginous sandstone was exposed." Report Sec'y War, Dec. 5, 1857, p. 497.

Again it has been seen by several observers at different times near Little Blue river, not far from the Kansas and Nebraska line,—lat. 40° and a little west of the 97° of west longitude. Here at an elevation of about 700 feet above the Missouri at Leavenworth, or three hundred feet below the horizon of the localities on Republican fork, and, five hundred feet below the elevation of the outcrops seen by us on the summits of the Smoky Hills, our deceased friend, Mr. Henry Pratthen, saw near Wyeth's creek, in 1853, the following exposures in descending order:

1. Slope, height not given.	
2. Yellow and whitish limestone filled with casts of *Inoceramus*, referred by him to *I. myteloides* =*I. problematicus*.	No. 3, Nebraska Sec.
3. Slope, thickness not given.	No. 2, Nebraska Sec.
4. Red ferruginous sandstone *with leaves of dicotyledonous tress.*	No. 1, Nebraska Sec.

A short distance west of this exposure Dr. J. G. Cooper informs us he saw outcrops of a red sandstone in the valleys at about the same elevation; and above this, exposures of dark gray laminated clay answering exactly to the description of No. 2, of the Nebraska section, while above the latter, near the tops of the hills, he met with outcrops of *light colored limestone containing numerous casts of Inoceramus.*

At other localities not far to the southwest of the foregoing, Mr. Hawn saw exposures of *light colored limestone* forty-five feet in thickness, *containing great numbers of Inoceramus* which we referred, from specimens sent by him, to *I. problematicus.** Below this there was a slope of twenty-seven feet in which he saw no exposures, while still lower he observed outcrops of *dark ferruginous and yellow sandstone, and various colored clays with impressions of leaves*, resembling, as he supposed, those of oaks and willows. (See his section published by us in the Proccedings of the Academy of Natural Sciences of Philadelphia, May, 1857.)

Proceeding northward from the last mentioned localities, we find on reaching the Loup fork of Platte river, near the eastern limits of the Pawnee reservation, outcrops of the light colored *Inoceramus* beds already mentioned, (No. 3, Nebraska section,) near the water's edge; and at the mouth of Loup fork, on the

* We have referred this species to *I. problematicus* with some doubt; it is the same species inscribed by Dr. Schiel in the second volume of the Pacific Rail Road Report, page 108, plate 3, figure 8. It is rather longer on the hinge than is common in *I. problematicus*, from which it may be distinct. We always refer to this shell in speaking of *I. problematicus*, in this paper.

Platte, the red sandstone No. 1, so often referred to, crops out near the river margin, *while the Inoceramus beds are seen in the bluffs above it.* Going down the Platte in a direction nearly contrary to the dip of the strata, we find this sandstone rising up so as to form near the mouth of Elk Horn river, bluffs some sixty feet in height. Here it seems to rest directly upon upper Carboniferous rocks. Continuing on down the Platte, we find this red and yellow sandstone rising higher and higher in the hills until we come within five or six miles of the Missouri, where it is seen with its base elevated near sixty feet above the Platte; and there are probably outliers of it between that point and the Missouri at greater elevations. So that we find the same formation which at the Smoky Hills, is elevated twelve hundred feet, —on the Republican river, one thousand feet,—and near Little Blue river seven hundred feet, above the Missouri at Leavenworth, has by the gradual northwestern dip of the strata, sunk to within about one hundred feet of the Missouri at the mouth of the Platte.*

Ascending the Missouri from the localities just mentioned, we see occasional exposures of the upper Carboniferous rocks, which gradually sink lower and lower until they pass beneath the river near Florence, to be succeeded by the reddish and yellow sandstones, &c., of No. 1.—(Nebraska section.) At localities along the river above this, occasional exposures of this formation are seen with its characteristic fossil leaves; and at several points, some thirty miles below the mouth of Big Sioux river, it forms perpendicular escarpments of yellowish sandstone rising from the water's edge to an elevation of about eighty feet; while at higher points, back on the summits of the hills, *the same calcareous beds are seen, containing Inoceramus problematicus.* Here at a quarry in the sandstone (formation No. 1,) some twenty feet above the level of the river, one of us (Dr. H.) collected a large number of fossil leaves, some of which are identical with species found by us in this rock at the Smoky Hill locality already mentioned. The sketches of leaves sent by us to Prof. Heer were mostly drawn from specimens collected at this locality.

At the mouth of Big Sioux river a low bluff of this formation, not more than fifteen or twenty feet in height, is seen, and on the hills back a little from the river, at a higher elevation, the same *Inoceramus* bed crops out at several places, and is used for

* The gradual descent of the Missouri river makes its surface at Fort Leavenworth, about three hundred feet lower than at the mouth of the Platte, hence the exposures of No. 1, seen at the latter locality, near one hundred feet above the Missouri, are some four hundred feet above the level of the Missouri at Fort Leavenworth, and of course about three hundred feet lower than the Little Blue river outcrops. The dip however, is greater than this would indicate, for the strata incline towards the northwest, while the mouth of Platte river, is northeast of the Blue river localities.

making lime. At another locality about eight or ten miles up the Big Sioux river, which comes in from the northwest, one of us (Dr. H.) saw No. 1, containing its characteristic fossil leaves, *directly beneath* No. 2, of the Nebraska section. The exposure presented the following beds in the descending order:

1. 20 feet exposed of light gray limestone and marl, containing *Inoceramus problematicus.*	No. 3, Nebraska Sec.
2. 45 feet dark laminated clay with ferruginous concretions containing fish scales.	No. 2, Nebraska Sec.
3. 15 feet exposed above the edge of the water, consisting of yellowish friable sandstone, with a thin bed of impure lignite above, and some layers of various colored clay below, containing *dicotyledonous leaves.*	No. 1, Nebraska Sec.

One of the sketches of a long lanceolate leaf, like some of the existing species of Salix, sent by us to Prof. Heer, was drawn from a specimen collected from one of the lower sandstones here.

Again at another locality on the Missouri, about thirty miles above the mouth of Big Sioux river, No. 1, was seen by one of us (Dr. H.) only five feet above the water's edge, and *immediately overlaid* by No. 2, of the Nebraska section, containing its characteristic species of *Ammonites;* and directly over the latter, he saw No. 3, containing *Inoceramus problematicus.** At this locality he also found in No. 1 some of the same fossil leaves that characterize it at the other places already mentioned.

On ascending the Missouri, above the last named locality, formations No. 2, 3, 4 and 5 are seen to sink at the same gradual uniform rate of dip, in regular succession, beneath the level of the river; so that on reaching Heart river, we find the top of No. 5 nearly down on a level with the water's edge, and a short distance above that locality, it passes out of sight to be succeeded by the Great Tertiary Lignite basin of the upper Missouri, which overlaps it on the hills along the river for some distance below.

From the foregoing statement, we think it will be clearly understood, that formation No. 1 of the Nebraska section holds a position *beneath* the other cretaceous deposits of that region; while the occurrence in it of the remains of highly organized angiosperm dicotyledonous plants proves that it cannot be older than Cretaceous. It may be argued, however, that it may in part be Cretaceous and part Tertiary, or at any rate that *some* of these leaves may have been obtained from overlying Tertiary beds which we have confounded with the Cretaceous below.

* It is of course unnecessary for us to inform geological readers that a rock overlaid by strata containing *Ammonites* and *Inoceramus*, cannot be Tertiary because these genera became extinct at the dawn of the Tertiary epoch.

This, however, is impossible, simply because specimens of nearly all the species found at the various localities have been quarried from the same bed at Blackbird Hill, and the whole,—not a part only—of this formation, passes beneath all the other Cretaceous rocks of the northwest. In addition to this, we have extensive collections of plants from the Tertiary of Nebraska, not a single species of which is identical with those from No. 1.

When we stated in some of our papers that it was possible we might have included in this formation beds not belonging to the Cretaceous, it was not because we thought any part of it might be Tertiary, but because we suspected some of the lower beds referred to it in Kansas might possibly be Jurassic; and we are even now prepared to believe that it may yet be found to repose on Jurassic rocks in that Territory, as it does at the Black Hills, in Nebraska.

Art. XXVIII.—*Geographical Notices.* No. VI.

Semenow's Explorations in Central Asia, 1857.—The trigonometrical survey of India, the exploring expedition of the Brothers Schlagintweit, and the researches of Russian travellers are making valuable contributions to our knowledge of Central Asia. In a recent number of Petermann's journal a highly important paper is presented in respect to the expedition of P. V. Semenow, in the neighborhood of the Balkasch lake. The article is based upon original data furnished by the traveller, and dated St. Petersburg, June, 1858.

We condense and translate such portions of the article as are most interesting, regretting that we are not able to transfer it entire.

To the south of the Russo-Siberian frontier and military post route, which follows the course of the Irtysh, there extends a wide and sterile tract, universally known as the Kirghese Steppe. This Steppe has a rocky substratum mostly crystalline, but in part also sedimentary, swelling into hills and occasionally aggregated into small and low mountain-clusters. Its characteristic features are aridity, the absence of trees, scarcity of streams, relatively insignificant height of the hills which hardly in a single instance deserve the name of mountains, and numerous salt-deserts with their accompanying halophytes (salt water plants).

But as we arrive at the river Ajagus, an eastern tributary of the Balkhash Lake, and pass beyond the low sandy downs, that by their depression, their saline character, and their numerous standing pools bordered with sedges, indicate a former connection between the Balkhash and the Ala-kul, we enter an entirely

different region. This long low mostly dry bed of what must formerly have been one continuous lake extending from the 74th to the 82d meridian east of Greenwich, forms a marked dividing line between the mountain-systems and general physical features of Central Asia on the south, and Siberia on the north. From this line onward we encounter a continuous series of magnificent Alp-lands, rising height above height till they at last blend with the Thian-schan, the most central of the mountain ranges of Asia. This line too forms a natural limit, north of which we no longer find many of the vegetable growths or the animals of Central Asia, such for instance as the *Populus diversifolia* and the *Pyrus Sieversiana* among trees, or the tiger, the hedgehog, the pheasant, &c., among animals.

Semenow's explorations, made in the year 1857, relate mostly to this Central Asiatic Alp-land, which though comparatively small in extent, is yet charming for the variety of its scenery, and attractive to the physical geographer for its union of so many different zones with their diverse characteristics of soil, of temperature, of vegetable and animal species, etc. It is bounded on the north as we have stated by the Balkasch-Ala-kul Lake belt, on the east by the snow-covered crest of the Dzungarisch Ala-tau, and on the south by the perpetual snows and glaciers of the Thian-schan, and it comprises all altitudes between the wide extremes of 600 and 2000 Paris feet.* This region, in addition to its interest for natural science, is also attractive to the ethnographer, as having been from the earliest times one of the most important stations for those vast wandering hordes which have successively overrun Europe. For here in the broad and fertile valley of the Ili they would often stop for several years, and then with the fresh strength and energy gained by their repose, take up their march around the southern shore of the Balkhasch, either northwest toward Europe, or southwest towards Turan, Southern and Western Asia.

The Ili divides this portion of Central Asia into two parts, the northern called "the land of seven rivers," the southern "the land across the Ili," (Transilian,) names given them by the early Russian settlers.

The distinctive features of this region are its three lofty Alp-lands, viz.:

1. The Dzungarisch Ala-tau, (closely connected with the Talki-chain that divides the Ala-kul and the Ili valleys,) with a medium ridge altitude of 6,000 feet, and a peak altitude of 12,000 feet.

2. "The Ala-tau across the Ili," between the Ili valley and the Issyk-kul plateau, with a medium ridge altitude of 8000 feet, and a peak altitude of not far from 14,000 to 15,000 feet; and

* Semenow's measurements are all given in Paris feet.

3. The Thian-schan, between the Issyk-kul plateau and the lains of Little Bucharest, with a medium ridge altitude of about 11,000 feet, and a peak altitude of perhaps 20,000 feet. The Dzungarish Ala-tau on its western slope and the Transilian Ala-au on its northern face decline directly into a broad Steppe-level hat stretches away at the varying elevation of 1500 to 500 feet o the Balkasch basin, and comprises the entire western and iorthwestern portion of this region. And the nearer we ap-roach to the Balkasch, the more flat, arid, unfruitful, sandy and aline does the soil appear, gradually becoming covered with the *Haloxylon ammodendron* and with halophytes; and the streams, which as they issued from the mountains were bright, clear and apid, become more sluggish and turbid till at last they come to stand amidst sandy downs and sedgy marshes, and but three f them, viz.: the Lepsa, the Karatal, and the Ili actually reach he Balkasch Lake.

But the transition zone between the mountain-land and this Steppe, is on the contrary, one of the finest agricultural tracts n the continent. It possesses a deep vegetable mould, a luxuri-us growth and such an abundance of water that the inhabitants, he Kirghese, the Buruti and the Russian Cossacks, apply an rtificial irrigation to their fields with surprising facility.

If we now take a general survey of this region in its practical daptations to the wants of its inhabitants we shall find that it ncludes four natural zones, each offering its peculiar tribute to he general welfare. 1. The Steppe-zone, 500 to 1500 and in ome places 2,000 feet above sea-level, affords most excellent winter quarters for the Nomads, on account of its mild climate nd its almost entire exemption from snow. 2. The agricultural zone, from 1,500 to 4,000 feet of altitude, contains rich arable ands. 3. The pine-tree zone, from 4,000 to 7,000 feet in altitude, yields abundance of timber wood for building; and 4, the Alpine neadow zone, from 7,600 to 9,000 feet in altitude, entices the Nomads by its wholesome air and its rich pasturage to resort hither during the summer. There are two other zones, viz.: he High-Alp and glacier-zone from 9,000 to 11,200 feet in alti-ude, with its brilliant flora, and the snow-zone, or the region of erpetual snow; but these will forever remain practically of no mmediate importance to colonists.

We omit Semenow's measurements and notes, geological, hysical and enthusiastically descriptive, taken during his ex-lorations in the Dzungarisch Ala-tau and the Thian Schan, and give briefly the results of his observations upon the Issyk-kul ake. Between the Transilian Ala-tau and the Thian-schan anges there is a plateau of 4,200 feet altitude, 230 wersts in ength, and 70 in breadth, in which the charming lake of Issyk-ul is situated. This lake is 150 wersts in its extreme length by

50 wersts in breadth. Its waters are brackish and unpalatable. It is fed by over 40 short mountain streams, which fertilize the otherwise sterile soil of the plateau, and which are fringed by long lines of trees. But little sedge is to be met with, and that only around the indentations of the lake. On the contrary, the *Hippophae rhamnoides* forms a thick bushy growth in the neighborhood of the shore. Between the mountains and the lake there is a belt of from 7 to 20 wersts in breadth. At one point only do we find the case otherwise, viz.: the Kesse Tsengyr on the northern shore, where a spur from the Ala-tau approaches so near the water that there is merely room enough left for a waggon road. The immediate border of the lake is in general low and sandy; but around some of the bights the land is more elevated and presents a steep descent to the water; in such places the beating of the waves frequently wears away the loose alluvial strata of which these bluffs consist, so that large masses will at intervals crumble into the lake. Semenow saw no islands in the Issyk-kul. From the fact that so many streams flow into it, he conjectured that it must at some point effect an outlet. Geographers had hitherto represented the river Tschu as such an outlet, but Semenow followed the Tschu up toward its source and ascertained that it approached the lake no nearer than 5 wersts. Here it breaks through a frightful gorge in the Byam mountain, a continuation of the Transilian Ala-tau, and flows N.E. to unite with the Kebin. If the waters of the Issyk-kul had at some previous period been about two hundred feet higher than they now are, (and there are water-marks near the base of the mountain which may warrant such a supposition,) then the lake may itself have opened the Byam gorge, and so discharged its surplus flood into the Tschu. Such a former high state of its waters will account for the frequent conglomerate strata on its banks, which were doubtless formed in the lake-bed, and brought to view on the recession of the waters. Semenow found moreover an additional argument for this hypothesis in a legend of the Buruti that the ruins of a submerged city are at certain seasons visible at the mouth of the Tub, and under the surface of the water. In fine his explorations led him to conclude that if it were not for the existence of the Byam gorge, there is no good reason why the Issyk-kul might not rise not merely 200 feet but many hundred feet above its present level.

It only remains for us now to speak of the temperature of the Issyk-kul plateau. Near Viernoie, the second Russian settlement on the military road to the Transilian Ala-tau, and directly to the north of these mountains, the ground is commonly covered with snow only in January and February. In the Issyk-kul plateau snow lies on the ground for over four months of the winter season. In the beginning of May when at Viernoie,

apricot and apple trees are in blossom, at Issyk-kul it freezes after sundown, and the use of furs is indispensable. Still we are surprised to learn that notwithstanding the elevation of the Issyk-kul it is never frozen, although some of its smaller bays are sometimes encrusted with thick ice. This fact is doubtless to be attributed to the temperature of the deep bed of the lake.

The Glaciers of the Tengri-Tagh.—The Tengri-Tagh, a colossal mountain range directly to the east of the Thian-schan, and whose loftiest peak, the Tengri-Khan, soars to a height, as estimated by Semenow, of 20,000 feet, exhibits on its northern declivities a series of glacier formations that are not surpassed in their dimensions by those of the Alps. Semenow informs us that he had hitherto doubted whether true Alpine glaciers could exist in such a dry climate as that of Central Asia. But the most essential features of their formation, viz.: an enormous accumulation of perpetual snow, and basin-like depressions towards the inner termini of the high mountain valleys, were here, and he could doubt no longer when his further explorations were at last "rewarded with the view of three Alpine glaciers and a vast glacier sea." "The valleys into which the glaciers of the Tengri flow are so flat and broad, and their slope is so inconsiderable, that the plastic ice can more readily expand on all sides into glacier seas, than move forward and downward." The Tengri glaciers differ from the Alpine in two respects, viz.: in the absolute level of their upper and lower termini, and in their color. The latter are sometimes found to reach a point 5,500 feet below the snow-line, while 2000 feet appears to be the utmost vertical extent of the former. And may not this lesser range of absolute level in the Tengri glaciers, joined to their lesser slope, permit the snow-light the more readily to stream through them, thus accounting for their water-green color, so different from the delicate blue that marks the glaciers of the Alps?

Trigonometrical Survey of India. Measurement of Himalayan Peaks.—In the last number of this Journal, it was mentioned that a third peak higher than the once preëminent Dhaulagiri had been measured near the Karakorum pass in the Kuen Luen Mountains. The information was communicated to the Royal Geographical Society of London, Nov. 23, 1857, and briefly reported in the Athenæum. The measurement (giving a height of 27,928 feet) was made by Messrs. Montgomerie and Elliott Brownlow under the direction of Col. Waugh.

Various inquiries having been made of us in respect to the measurement of the peaks in Central Asia, we give in this connection the data reported by Col. Waugh, to the East India

Company, concerning the measurement of the four famous peaks of the Himalayas.*

Name of the Peak.	Station of Observation.	North latitude.			Longitude East from Greenwich.			Height above sea level in English feet.
Choomalari or I.	Senchal, H. S.† ..	27°	40′	41,5″	89°	18′	43,1″	23,946
	Tonglo, H. S. ...	"	"	41,5	"	"	43,1	" 41
	Mean,..	27	49	41,5	89	18	43,1	23,946
Kinchinjunga or IX.	Doom Dangi, T. S.	27	42	9,5	88	11	26,4	28,151
	Senchal, H. S. ...	"	"	9,3	"	"	26,2	" 50
	Birch, H. S.	"	"	9,4	"	"	26,2	" 63
	Thakoorganj, T. S.	"	"	9,8	"	"	26,7	" 47
	Tonglo, H. S.	"	"	9,3	"	"	26,2	" 80
	Bunderjoola, T. S.	"	"	9,2	"	"	26,1	" 42
	Menai, T. S.	"	"	9,2	"	"	26,3	" 72
	Baisi, T. S.	"	"	9,6	"	"	26,3	" 60
	Harpoor, H. S. ...	"	"	9,5	"	"	26,3	" 40
	Mean,..	27	42	9,4	88	11	26,3	28,156
Mount Everest or XV.	Doom Dangi, T. S.	27	59	16,5	86	58	5,8	—
	Menai, T. S.	"	"	17,1	"	"	6,1	28,990
	Harpoor, T. S. ...	"	"	16,5	"	"	5,7	9,026
	Ladnia, T. S......	"	"	16,7	"	"	5,8	8,999
	Janjpati, T. S.....	"	"	16,7	"	"	6,0	9,002
	Miriapoor, T. S. ..	"	"	17,0	"	"	5,8	9,005
	Lirol, T. S.	"	"	16,7	"	"	5,8	8,992
	Mean,..	27	59	16,7	86	58	5,9	29,002
Dhaulagiri or XLII.	Ramnagar, T. S...	28	41	47,9	83	32	8,8	—
	Morairi, T. S.	"	"	48,1	"	"	8,3	26,815
	Banarsi, T. S.	"	"	48,1	"	"	8,7	" 00
	Slaonbarsa, T. S. .	"	"	47,8	"	"	8,9	" 60
	Poovenah, T. S. ..	"	"	47,8	"	"	8,9	" 43
	Ghaos, T. S.	"	"	48,2	"	"	8,2	" 06
	Toolsipoor, T. S...	"	"	48,2	"	"	8,4	" 01
	Anarkali, T. S. ...	"	"	47,8	"	"	8,8	" 00
	Mean,..	28	41	48,0	83	32	8,6	26,826

We also give the following general account of the progress of the Trigonometrical Survey of India, from the annual address of Sir R. I. Murchison, in 1858, as president of the Royal Geographical Society.

"The trigonometrical survey of India was commenced by Colonel Lambton in 1803, and continued by him till his death in January, 1823. During that period he measured an arc of

* v. Peterm. Mittheil. 1856, p. 380.

† H. S. signifies Hill Station, and T. S. Tower Station.

the meridian from Punnae in 8° 9′ 35″ near Cape Comorin to Damargidda in lat. 18° 3′ 16″, being about ten degrees of latitude, and extended a net of triangles over the south part of the peninsula of India, reaching on the east side of the principal meridian to the 19th parallel. Colonel Everest, who had been his chief assistant since 1817, and succeeded him at his death, completed the section commenced by Lambton, and extended the arc to Seronj, lat. 24°, near which place he measured a base of verification. This is the most important base in the trigonometrical survey of India, as all the work to the north, east, and west is dependent upon it. Colonel Everest carried on the measurement of the meridional arc to its completion in the Dehra Dún, lat. 30° 19′; the whole extent from Cape Comorin being 22½° of latitude. He also extended a longitudinal series from the Seronj base to Calcutta, in the neighborhood of which he measured a base of verification. From points selected on this series originate distinct sects of meridional series, the northern limits of which are united by a longitudinal series running along the foot of the great mountain chain, which thus completes the triangulation of that vast tract, comprising about 223,000 square miles.

"When this distinguished officer left India, Colonel, then Captain Waugh, who had been his chief assistant since 1832, was appointed his successor in December, 1843, and following up the admirable plan of survey laid down by his predecessor, the principles and methods of which have been described by Everest,* he worked out the several series left unfinished between the meridional arc and that of Calcutta. Finally he measured a base of verification at Sonakoda, lat. 25° 18′, long. 88° 18′, and also completed the triangulation of the south coast series from Calcutta to Ganjam.

"Colonel Waugh then commenced operations on the west of the great meridional arc, and measured a longitudinal series from the base of Seronj, passing through Rajputana and the sandy desert to Karachi, upwards of 700 miles in extent, where a base of verification was measured, whilst the triangulation of the Bombay meridian was connected with this series. He further extended another series in a northwest direction from the stations of the meridional arc, Banog and Amsot, through the plains of the Panjab and a great portion of the mountainous tract to Peshawar. Again, a base of verification was measured near Attock, the series embracing an area of about 67,000 square miles. A meridional series is far advanced from the base at Karachi, along the Indus, to that near Attock. This operation will complete a gigantic geodetical quadrilateral, of

* Account of the Measurement of the Arc of India, 2 vols., 4to, 1847.

which the great arc series forms the eastern side. Simultaneously with these trigonometrical operations, most minute and elaborate topographical surveys have been executed under the superintendence of Colonel Waugh throughout the greater portion of these tracts.

"Lastly, having determined that of all the mountains whence the affluents of the Ganges run, the loftiest summit is situated about midway along the Himalayan chain, and finding that this culminating point (N. lat. 27° 56′, E. long. 86° 53′) was 29,002 English feet above the sea, and consequently 846 feet loftier than the famous Kinchinjunga of Nipal, Colonel Waugh has gratefully and appropriately named this, the highest known elevation in the world, Mount Everest, after his valued geographical instructor."

CENTRAL AFRICA. EXPEDITIONS OF CAPT. BURTON AND DR. ROSCHER.—Our readers are already acquainted with the expedition of Capt. Burton, and of his determination to reach, if possible, the mysterious lake of Central Africa, by penetrating westward from the coast of Zanzibar. Letters received from Rev. J. Rebmann, missionary at Zanzibar, by the Church Miss. Soc. of London, and published in their Record for December last, state that Capt. Burton had reached the lake Uniamesi, but give no further particulars in respect to his journey. Three letters from the explorer himself giving his observations in Zanzibar, written in a spirited style, are given in Blackwood's Magazine for February, March and May, 1858.

The missionary letters just alluded to, announce also the arrival in Zanzibar of the German traveler, Dr. Albrecht Roscher, and of his departure for the reported snow peaks near the equator. Dr. Roscher is represented as qualified in every way, by his previous studies, his energy of character and his excellent outfit, to undertake this difficult exploration. He proceeds under the patronage of the king of Bavaria. From his efforts and those of Burton, we have good reason to expect that two of the great African problems will be solved, the extent of the great lake, and the height of the equatorial mountains. There is reason to hope that light may also be thrown on the older problem of the sources of the Nile.

From a recent number of Petermann's Journal (1858, p. 344) we have translated the following passages which occur in a paper by Dr. Roscher, showing the reasons for his selection of the coast of Zanzibar as a point of departure for Central Africa.

In projecting the plan of an exploring expedition into Central Africa we must depend mainly upon the history of travels in those parts: for these will both suggest what is still to be accomplished and instruct us as to the means to be employed and the course to be pursued. A due regard to the experience

of earlier travelers will alone enable us to discover new routes into unexplored regions, upon which we need not expect to meet with those insurmountable barriers that have presented themselves to our predecessors; and yet the ready abandoning of expectations, prematurely indulged in respecting earlier and more recent expeditions, is a source of greater surprise than the fact that so large a portion of Africa remains unexplored.

All the accounts of travels, which have aided us in the construction of the map of Africa, do not give us any information relative to the central and northern portions of the interior of Africa, although these regions contain the solution of the most important geographical questions, and furnish the key to a proper conception of the physical features of the continent. The remarkable travels of Livingstone prove that an expedition into South Africa is attended with difficulties comparatively small, and that the failure to advance farther into the interior must be attributed, not to the hostility of the natives and the unhealthy climate, but mainly to the selection of an unfavorable starting-point. The course which has thus far been most frequently pursued, that of approaching the interior from the north, is the least practicable. The traveller meets with obstacles at the very boundary which separates the Mohammedan and heathen tribes; for among the former, fanaticism and avarice, among the latter, the fears of slavery, prevail, and every one advancing from the camp of the enemy is regarded as a spy. These insurmountable barriers have existed since the occupation of Africa by the Mohammedans, and here it was that the Arabian geographers, in their additions to the geography of Ptolemy, imagined the snow-covered Mountains of the Moon to be situated.

The Nile-expedition was thus prevented from penetrating any farther than the breadth of the river afforded them a protection against the assaults of the natives, which rendered it impossible for them to reach the source of the Nile. Dr. Barth also was convinced that an advance into South Africa from Lake Tsad was impossible, and hence, contrary to all instructions, he directed his course westward so that the original object of the expedition was not attained. Dr. Vogel was next sent out, and strong hopes were entertained that he might meet d'Escayrac at the source of the Nile, although even at that time it might have been proved that this point was the last one at which the two expeditions would be at all likely to meet. Dr. Vogel's journey to Waday furnishes the strongest proof that he, like his predecessors, was convinced that the so-called Mountains of the Moon, even if in reality no mountains, yet constituted an insurmountable barrier.

The time has certainly come when merely fruitless attempts must be done away with, and when travellers into Southern

Africa ought to take their point of departure in South Africa. There is no means of direct communication between any point on the western coast and Europe or with the Interior, and hence none is suitable for the fitting out of an expedition. The true condition of affairs in this region, may be best inferred from the opinion of Galton, who assumed that a traveller could advance into Africa only very gradually. Finding the arrangements previously made not suitable to the climate of the regions to be traversed, the traveller would be forced to return for the purpose of entering upon new preparations.

The expedition of Caillié, Bruce and Livingstone, prove how erroneous this assumption, and yet it is applicable to such travellers as seek to advance from the western coast, and by reason of the imperfect means of communication, daily meet with difficulties of which they could not have had any previous knowledge. Besides, the seaboard towns are, as a general thing, very unhealthy, and the fever is specially severe upon those newly arrived; so that the explorer on returning need not expect to experience a relief from his toils, but only new dangers.

The successful expedition of Dr. Livingstone has turned the attention of all to South Africa. The point of departure in his expedition, was Lake Ngami, a point equidistant from the eastern and western coasts. He congratulated himself upon the peculiar advantage of his seeming to be a traveller toward the country of the whites—homeward; for the savages can comprehend the utility of such a journey, and unless this is clear to them, they become suspicious and anxious to drive the stranger from their borders. In view of so important an advantage, this route cannot be too highly recommended to such as are in a situation similar to that of Dr. Livingstone, or do not dread the expense of a preparatory journey from the Cape to Lake Ngami; that is, to such as are willing to spend some time in that unhealthy region, in order to become acquainted with the country and its inhabitants, and then return once more to the cape to prosecute the final preparation for a more extensive expedition. North of Livingstone's route one can not expect to meet with a beaten path or with other travellers, hence the preparations must be more extensive, many requisites for the journey must be carried by the party, circumstances which will considerably increase the expenses. To other travellers this route will prove less desirable, from the fact that on the eastern coast there is a point which presents all the facilities requisite for the fitting out of an expedition; at this point too, the means of communication with Europe and the interior are adequate, nor will the traveller here meet with that great obstacle, the hostilities between the Mohammedan and natives. Nor here will he expose himself to a loss of life and health. Such are the advantages that the island of Zanzibar presents.

From this general survey of the difficulties of travel in Central Africa, Dr. Roscher proceeds to consider in an interesting manner, the characteristics of Zanzibar, but our limits do not permit us to follow this portion of his remarks.

North and Central Australia. Gregory's Expedition. Leichhardt's Fate.—In the last number of this Journal some account was given of recent explorations in South Australia, especially in the neighborhood of Lake Torrens.

We have since received from Rev. W. B. Clarke of Australia, a communication addressed by him to the Sydney Morning Herald of Sept. 10, 1858, in respect to the probable fate of Leichhardt, which gives us an occasion to refer to the explorations in the northern and central parts of the continent.

It is well known that the question has been much discussed in respect to Australia as well as in respect to Africa, whether or not in the interior of the continent, a great sea exists. Eyre, whose explorations were made in 1840 et seq., adhered to the belief that no such sea existed. On the other hand, Sturt, journeying north from Adelaide, 1844–6, although failing to discover an actual sea believed in its existence. The following remarks are given in his own words.

"The principal features of the interior are the sandy ridges or dunes, by which it is traversed from south to north, and the Great Stony Desert. That the whole region traversed was once submerged, there cannot, I think, be a doubt. Its salsolaceous productions, its sea-level, its want of trees of any size or growth, excepting on the banks of the creeks, sufficiently attest this; but whether the sandy ridges were thrown up simultaneously, or were successively formed by a joint effect of winds and a gradually retiring sea, or of winds alone, it is impossible to say. When I first crossed the Stony Desert, it appeared to me to have been the bed of a former current; and I felt satisfied that the conclusion was just when I crossed it at another point more than a degree from the first, and noticed the strong proof it exhibited of waters having at one time or other swept over it with unresistible fury. Whether the Stony Desert continues to any distance I cannot say, but my opinion is that it does, and that, as the lowest part of the interior, *it receives all the waters falling inwards from the coast.* Whether those waters are gradually lost by evaporation, or that they are carried to some still undiscovered sea, remains to be proved; but as it is difficult for others to elucidate these things, I have thought myself called upon to throw every light I can on the probable character of the interior. All I can say is, that after having traversed a desert for 400 miles and failed to reach its northern limit, and after having found that it continued unaltered for four degrees of longitude,

I cannot hope that it speedily closes in, either to the east or west."

In 1848, Leichhardt, whose previous journeys had made important additions to our knowledge of the northeastern parts of Australia, set out with a party of eight men to cross the continent from east to west, expecting to be gone two years and to determine the great question in respect to the interior. No news has been received from him since a short time after his departure. Hopes were entertained that Gregory's expedition would bring some news of his course and fate, but these expectations are disappointed.

An outline of Gregory's tour is thus given by Sir R. I. Murchison, on awarding to him the Founder's gold medal of the Royal Geographical Society of London.

"Having ascended the Victoria as far as was practicable, Mr. Gregory established a camp on the right bank of this stream, and at about 80 miles from its mouth. With his brother, Mr. H. Gregory, Mr. Wilson the geologist, and Dr. Ferdinand Mueller the botanist, he then explored the Victoria to Jasper Creek, determining the geological nature of the country, and ascertaining that the river made a great southward bend. Again taking with him his brother, and Dr. Ferdinand Mueller, together with the artist, Mr. Baines, he marched southwards to ascertain if the saline desert, which Sturt had discovered in proceeding inland from the southern regions of Australia, and which he had himself found to prevail in Western Australia, was also to be met with in a journey southwards from the north coast.

"For this purpose he ascended the Victoria to its source, and found the hilly or dividing range to have an altitude of 1660 feet above the sea. Traversing this watershed, he descended by a south-flowing stream, which he named Sturt Creek, and which, bending to the S.S.W., terminates in a desiccated salt lake near Mount Wilson, in S. lat. 20° 2′ and E. long. 127° 5′. Whilst the southeastern and southern slopes of the dividing range were thus proved to be everywhere dry and sterile sands, the whole of the territory to the north of the same presented the most striking contrast, being generally very fertile in grasses, particularly the extensive grounds named Hutt Plains and Roe Downs.

"In this first effort, therefore, made specially by the advice of our medallist Sturt, the grand geographical and statistical feature which was suspected to exist was brought to the test; and we may now fairly infer, that all the central portion of this continent, as well as the long southern coast-line examined by Eyre, and a considerable maritime frontier of Western Australia, constitute an uninhabitable desert, probably the dried-up bottom of a sea, and that hence all future intercourse between our Australian colonies must take place either along the fertile coast ranges, or by sea.

"Returning to his camp, which he had left under the charge of Mr. Wilson, the geologist of the expedition, who had in the mean time examined the adjacent country, of which he sent home sketch maps to this Society, Mr. Gregory sent away Mr. Baines the artist, with Mr. Wilson, and the larger number of his party, in the schooner; and after giving directions that the vessel should meet him at the head of the Gulf of Carpentaria, he set out on his chief mission, accompanied by his brother, Mr. Elsey the surgeon, Dr. Mueller the botanist, and three men.

"Quitting the basin of the Victoria, and passing over a broad table-land of sandstone, he entered a valley watered by a tributary of Leichhardt's river the Roper, which he named Elsey Creek, in S. lat. 15° 15′ and E. long. 133° 10′. He next took a south-southeasterly direction to the west of Leichhardt's route, or about 70 miles distant from the western shore of the Gulf of Carpentaria, and traversed the various rivers discovered by his adventurous precursor (but nearer to their sources) until he reached the Albert, which empties itself into the head of the Gulf. Not meeting there with the party sent by sea, under the orders of Mr. Baines, he left the 'Plains of Promise' of Stokes, and crossed the river Flinders at about 80 miles distance from the Albert, and, journeying to the northeast, fixed a position on the Gilbert river at S. lat. 18° 0′ and E. long. 140° 40′. Ascending that stream, Mr. Gregory left behind the drainage into the Gulf of Carpentaria, and traversed the high basaltic plateau which separates the waters flowing into that gulf from those which descend into the great eastern ocean. To the dividing high lands he assigned the name of 'Newcastle Range,' in honor of the Secretary of State for the Colonies, who had sanctioned and organized the expedition. Reaching the Burdekin, he followed that stream southeastwards to its junction with the Cape river of Leichhardt.

"The next march showed the connection of the Suttor of Leichhardt with the Belyando of Mitchell; then striking southwest from the latter stream, Mr. Gregory skirted the Peak range, the extreme point to which squatters have extended their dwellings, *i. e.* in S. lat. 23° 41′ and E. long. 147° 50′, or about 560 miles from the head of the Gulf of Carpentaria.

"Whilst a great breadth of entirely-sterile tracts, with one insulated rich spot only on the river Roper, prevail between the basin of the Victoria on the north coast and the Gulf of Carpentaria, with occasional poisonous plants, Mr. Gregory found nearly all the vast region between the eastern side of the gulf and the northernmost station of our settlers to be more or less fertile. So that in the last weeks of the expedition the horses fattened, and after traversing the rivers Mackenzie, Comet, Dawson, and Burnett, the party reached the Brisbane and Moreton Bay in excellent health."

The publication of Mr. Gregory's report, without any decisive indications of Leichhardt's route, led Mr. Clarke to prepare the paper already referred to in the hope that the discussion might initiate another expedition into the district yet unexplored, between the 145th and 147th meridians, and which, as he conceives, may bear traces of Leichhardt's route, although the explorer probably perished far to the northward and westward of the Victoria. We have not room to make extended extracts from this paper. Its whole tendency is to show that the intention of Leichhardt was to skirt and not cross the desert. There is an extended criticism to show the probability that an L found by Gregory on the Victoria, and two marks XVA in an L-shaped border previously found near the Warrego and the Nive were not the marks of Leichhardt. Various independent witnesses are also cited to confirm the opinion of Mr. Clarke that Leichhardt did not attempt to intersect the desert. The article concludes as follows.

"If then he did reach the Victoria in 1848, and was not cut off, and we have now no ground to conclude he was, he would, in case of finding the country impracticable to the west, have gone round by the head of the Victoria, towards the north, and it is somewhere between the head of the Victoria and the head of the Clark, that, I think, his tracks are to be looked for; not, probably, on any line of route explored by Mitchell, but to the westward, or, crossing Mitchell's track, on a line to Peak Range and the Burdekin. Or driven in by drought, he may have taken a course on the 148th meridian, without going across the Maranoa, where Hely could not trace him, on a new track of his own.

"It is in the hope that a new expedition may be organized, with a view to the exploration of the country west of Mitchell's Belyando, as well as to ascertain whether any traces of my lamented friend can be found, that I have made this communication; believing that, as I have had it in my power to put the matter in a tangible form, and to quote from manuscript notes in my possession, what has not before been committed to the press, I am only rendering a service to the cause of science, civilization, and humanity."

The following paragraph may be read with interest in this connection. It is a letter of Dr. J. Palacky of Prague to Prof. C. Ritter of Berlin, printed in Poggendorf's Annalen für Chemie, vol. 100, 1857.

"The statement of Sturt that Lake Torrens must lie below the level of the sea, led me to think that Central Australia must lie very deep. I found unfortunately no other data than in Sturt, Bd. ii, p. 299, where in connection with Kennedy's route to the Victoria river—it is mentioned that in lat. 25° 55′ 37″ and long.

142° 24′, the water in the camp when the air was at a temperature of 64° Fahr., had boiled at 214° F. Prof. Coritska, who directs the height measurements of our Geological Reichsanstalt, undertook at my request the computation of these data and found that if they are correct, this point must lie 306 meters below the sea level."

ART. XXIX.—*Analysis of the White Sulphur Water of the Artesian Well of Lafayette, Indiana;* by CHARLES M. WETHERILL, Ph.D., M.D.

History of the Well.—The artesian well of Lafayette is situated in the northeast angle of the court-house square of the city. The boring was commenced in the spring of 1857 by order of the Commissioners of Tippecanoe county to test the feasibility of artesian wells for prairie farms, and with prospects of success from the results of the wells in Illinois to the southwest. On February 18th, 1858, after ten months labor, a vein of overflowing water was struck in the grey limestone, at a depth of 216 feet 6 inches. The depth of the well was subsequently increased to 230 feet without any change in the character of the water, which is very similar to that of the celebrated Blue Licks, of Kentucky. The strength of flow of the water began to diminish, and while injudiciously boring for more water instead of trying to stop a known leak, the water suddenly ceased to overflow, and fell in the well about 20 feet. As there was no prospect of the recovery of the water by the contractor, the County Commissioners placed the well in the hands of Captain Rogers and myself, for the purpose of obtaining some experimental knowledge with respect to the source of the difficulty. Before giving the results of our experiments, I will submit a table which shows the order and nature of the strata encountered in boring the well:

Table of Strata encountered in the Lafayette Well.

	Feet.	Inches.	Remarks.
Clay........................	3		
Clay and gravel..............	9	6	Water.
Gravel and pebbles	1	6	
Fine gravel and sand..........	13		
Quicksand	1		
Gravel, clay and pebbles.......	2	6	
Dark gray clay	72		Marlite.
Sand and gravel	4		Water.
Clay and pebbles.............	1	3	
Sand and gravel..............	7	3	
Clay.......................		6	

	Feet.	Inches.	Remarks.
Sand and gravel..............	3		
Clay and pebbles.............	6	6	
Gravel and pebbles...........	5		
Boulders.....................	40		
Blue shale...................	2		To shale 170 feet.
Gray "	18		Iron pyrites in all the rock
Blue "	1	6	formation.
Gray "	7		Thickness of shale 28 ft. 6 in.
Limestone—coralline..........	11	6	To coralline, 198 ft. 6 in.
Gray limestone with spar......	20		Overflowing water.
Depth of well from original surface	230		

The first water in the table is the well water of the locality. The water under the marlite is fresh; it was expected to overflow but only rose to within 36 to 38 feet of the surface. The third and overflowing water is the mineral water.

A cast iron pipe of eight inches diameter cases the well to the first rock, which is a friable blue shale. The hole in the rock was not tubed, it was of 7½ inches in diameter to near the commencement of the coralline; for a few feet farther it was of five inches, and for the remaining distance of twenty-one feet its diameter was four inches. We found that the bottom of the iron pipe had been broken during its passage through the forty foot bed of boulders, and as this fractured end rested upon a friable bed of blue shale with porous strata immediately above, a leak of the mineral water had always existed. From an experiment made during the overflow of the water we were able to assign a delivery of eighteen thousand gallons during twenty-four hours as the lowest capacity of this leak. We found that the cessation of overflow was caused by the leak having been increased by the removal of a piece of the shale rock. Restoring the overflow by stopping this leak was the natural inference from the experiments upon the well; but there were difficulties in the way owing to the bad shape of the hole in the rock, by the use of improper boring tools. The holes were all of triangular shape, and the four inch hole was especially bad, having reëntering sides and semicircles at the three angles. We might have arrested the leak by tamping and puddling at the end of a long tube below it, but were fearful of presenting difficulties thereby in the case of the removal of such a tube, for as the leak at the top of the shale rock had always existed, we had no means of knowing whether some of the mineral water was not derived from the shale, and would be shut out by such a tube.

The leak was at length arrested by the following device of my own, which I submit in the event of a future need for it, as it proved simple and successful in the Lafayette well, and I am not aware that it has ever been employed in a similar case. The

commencement of the four inch hole was made truly cylindrical and of six inches in diameter for a distance of nineteen inches. A car spring of vulcanized india rubber was turned in a lathe to the shape of the frustum of a cone six inches in length, and of diameters six and a quarter and five and seven-eighths inches. Upon a wrought iron gas pipe of two and a half inches bore and of sufficient length to reach the coralline rock, was chised a screw thread upon which ran two heavy nutts. The hole in the rubber plug was turned sufficiently large, that the plug might be screwed tightly upon the gas pipe, where it was secured for pulling or pushing by the nutts above and below it. When the pipe was placed *in situ* in the well, the plug was arrested in its rocky socket just above the commencement of the coralline rock. The water at once fell outside of the gas pipe, and rose on the inside to near the surface of the ground. After two days it commenced to overflow and increased constantly and steadily. The increase at first was very rapid, the delivery doubling itself in five hours; a repeated and careful measurement of the quantity of water showed that the *rate of increase* fluctuated, and became gradually less. This compelled the inference that the leak had lowered the head of water in the reservoir supplying the artesian well, which head was gradually restored by the rains, springs, &c., upon shutting off the leak. This increase in the flow will go on until the overflow equals the feed of the reservoir. When the delivery was last measured on December 8th, it equalled one wine gallon in 14·77 seconds, or 5850 gallons in twenty-four hours.

Geology of the well.—The order and character of the rocks in proceeding from a point west to one east of Lafayette, is from information furnished by D. Brown, State Geologist, as follows:

1. Seams of Coal.
2. Mountain Limestone about 200 feet in thickness.
3. Clay Sandstone (Devonian) about 500 feet.
4. Delphi Slate varying from 25 to 100 feet, and thinning to the northwest.
5. Grey Limestone (Upper Silurian).
6. Blue Limestone (Lower Silurian).

The dip of these rocks is about 25° to the south of west, and at an angle of 50 feet fall to the mile. This westward dip is maintained until the Mississippi is crossed, when the dip is eastward. The sequence of the rocks, in penetrating the earth vertically at Lafayette, should be Clay Sandstone, Delphi Slate, and Grey Limestone; but the valley of the Wabash at the artesian well is about one hundred feet below the general elevation of the country, and the force which has scooped out this valley has removed the Clay Sandstone, not a trace of which was discovered in boring the well. The Delphi Slate was the first rock reached

after traversing the drift, and the bottom of the well is situated in the upper measures of the grey limestone. A crude idea of the strike of these rocks may be gained by tracing upon a map of Indiana the strike of the Delphi slate, by a curved line joining Louisville, Ky., Lexington, Ind., Elizabethtown, Indianapolis, Delphi and Crown Point, Ind., which shows that the well is situated upon the edge of a great geological basin. As far as our present geological knowledge goes, (and which is limited owing to a backwardness on the part of the State Legislature in making the appropriations necessary to a survey,) the reservoir of the artesian well must lie in the direction of and beyond Delphi, for the water comes from below the slate cropping out at this locality. A glance at the map will show by the river courses, that Kokoino is the highest ground in the neighborhood; hence we shall probably not be far from the truth in assuming the reservoirs to be situated somewhere in the triangle formed by joining Delphi, Logansport and Kokoino. During the experiments upon the well by Captain Rogers and myself, one of the greatest freshets in the Wabash, within the memory of the inhabitants of the valley took place. The leak had not yet been stopped, and we found that the water in the well rose and fell simultaneously with the freshet. It is reasonable to suppose that this effect of the freshet was not upon the mineral waters but upon the water under the marlite (see table of strata); for the smaller freshets in the river since the leak has been stopped have not in the least affected the flow of the well. This can only be accounted for by supposing that the 72 foot bed of dark grey clay crops out under the Wabash at a level lower than that of the ground at the well. It follows from this that we cannot expect an overflow of this marlite-water in the neighborhood of Lafayette. In fact since the completion of the mineral well, three other wells have been dug in the city for the expressed purpose of reaching the marlite-waters. .It was obtained in every instance, but did not overflow.

CHEMICAL ANALYSIS OF THE WATER.

Physical Characters.—This water is of extreme limpidity when taken freshly from the well. The deposit upon the pebbles over which it flows is *white*, entitling it to the name of a *white sulphur* water. Standing in imperfectly closed vessels, a similar bluish white deposit takes place, which under certain conditions contains black flakes of sulphuret of iron. The smell of the water is strongly of sulphuretted hydrogen. The taste is similar to that of the celebrated Blue Lick water, though less strong. It is pleasantly brackish, resembling in taste, the liquor from oysters freshly opened. The density, from a mean of six observations is 1·00523.

The temperature, noted at intervals since the water was first obtained, (Feb. 18th to December 8th,) remained constantly between 55° and 56° F., my thermometer not being sufficiently delicate to give more definite results.

Although the mean temperature of Lafayette is unknown,* I have no doubt from other considerations, that the artesian water is "thermal;" for, first, the calculated temperature of the water upon the Grenelle basis renders this, in absence of contradictory facts, most probable. It will be remembered that thermometers placed in the wells of the Paris observatory stand invariably at 53° F., at a depth of ninety feet, and that from the increase of temperature at increased depths observed in boring the Grenelle well, the fact was established that the temperature rises one degree F., for every $61\frac{3}{10}$ feet, after the first ninety feet. After taking ninety feet from the depth of the Lafayette well there remain 140, and if the same ratio of increase of temperature exists as at Grenelle, the water should have a temperature of $2\frac{1}{4}$° above 53°=$55\frac{1}{4}$°, which agrees closely with the temperature actually found for the Lafayette water. Secondly, we infer that the artesian water is "thermal" from the fact that its temperature is above that of the neighboring springs and wells, as may be seen from the following table, which contains wells and springs situated at different points of the compass from the artesian well, and within a circle of two squares radius.

Temperature of the Wells and Springs of Lafayette, taken April 30, 1858.

	LOCALITY.	Depth Feet.	Direction from Artesian well.	TEMPERATURE. Air.	Water.
Well,	Mr. C. Taylor's dwelling,	25	South	78° F.	51° F.
Well,	Courthouse yard,	16	Southeast	"	51°
Well,	Wilstach's Drug Store,	16	North	"	48°
Spring,	Two squares from Artes. Well,		North	81°	50°
Well,	Mr. Benbridges' dwelling,	20	Southeast	80°	49°
Spring,	Messrs. Taylor & Co., lumber yard,		Northwest	"	50°
Well,	Cellar of Mr. J. Mix's store,	16	West	56°	49°
Well,	Lahr's Hotel,	16	East	80°	50°
Artesian w'll,				80°	55–56°

Chemical Characters. Qualitative.—The water is faintly acid from sulphuretted hydrogen and carbonic acid, but becomes neutral after having been boiled, owing to the expulsion of these gases. It follows from this fact that *all* of the sulphur is in the state of sulphuretted hydrogen dissolved in the water, and from the neutrality after boiling, that alkaline carbonates are absent. A particular experiment for the search of a trace of alkaline carbonates gave the same results.

Carbonic acid is contained dissolved in the water, and holding in solution the earthy carbonates. Nitrogen is the only remain-

* The mean temperature is probably 51° to 52° F.—EDS.

ing gas in solution. On boiling the water the carbonates of lime, magnesia and iron, held in solution by the carbonic acid, are thrown down, and by a slight concentration, sulphate of lime is also precipitated. In the boiled water chlorids of sodium, calcium and magnesium, were detected. Crenic and apocrenic acids were in vain sought. A trace of organic matter was found dissolved in the water. The only alkali present is soda in the state of chlorid of sodium. No trace of potassa was discovered after a careful search. Mr. H. C. Lawrence kindly undertook the concentration of eleven and a half wine gallons of the artesian water, which were boiled down to half a gallon; a concentration in the ratio of 23 to 1. In the solid residue and filtrate, I detected phosphate of lime, hydrofluoric acid, alumina and a very faint trace of oxyd of manganese. A small trace of iodine was discovered in the mother liquid, both by the starch test and by chlorid of palladium. With the starch test the characteristic blue tinge could not be developed by chlorine water, the excess of chlorine decolorizing the extremely minute quantity of iodid of starch; but it was readily brought out by nitric acid. The result of the bromine test by Fresenius's method was doubtful.

Quantitative analysis.—The quantitative analysis gave the following results:

	Per mill.
Mean of two exp., sulph. acid determination,	0·5621
" " chlorine,	3·7807
Sodium by calculation, (loss,)	2·1782
" " experiment,	2·1683
Peroxyd of iron, mean of two exp.,	0·0085
Silica,	0·0080
Lime—total,	0·5386
" after boiling the water, in the precipitate,	0·1149
" " " " " in the solution,	0·4255
Magnesia—total,	0·2005
" after boiling the water, in the precipitation,	0·0039
" " " " " in solution,	0·2088

Sulphur, carbonic acid, and nitrogen as stated below. These data calculated according to the ordinary rules give the following result:

Composition of the White Sulphur water of the Lafayette Artesian well. Water of March 25th, 1858.—Temperature 55°–56° F. Density, 1·00523.

GASEOUS CONTENTS.

	In 1000 grams. Grams.	In 1000 grams. Cub. centim.	In a wine pint. Cubic inches.
Sulphuretted hydrogen,	0·0093	6·3594	0·1841
Ditto water of April 8,	0·0145	9·9154	0·2870
Carbonic acid,	0·0997	52·683	1·5253
Nitrogen,		21·280	0·6160

SOLID INGREDIENTS.

	In 1000 parts by weight.	Grains in a wine pint.
Residue by evaporation, Pure water, ...	992·75	7274·446
Solid ingredients, ...	7·25	53·124
	1000·00	7327·570*

INGREDIENTS BY ANALYSIS.

Carbonate of lime, ...	0·2052	1·503
Carbonate of magnesia, ...	0·0069	0·050
Peroxyd of iron with alumina, ... Phosphate of lime, fluorid of calcium, ... And a faint trace of manganese, ...	0·0085†	0·062
Silica, ...	0·0080	0·058
Sulphate of lime, ...	0·9555	7·002
Chlorid of calcium, ...	0·0635	0·465
Chlorid of magnesium, ...	0·5059	3·707
Chlorid of sodium, ...	5·5402	40·596
Trace of iodine and organic matter, ... Bromine doubtful, ...		
	7·2937	53·443

I have recalculated the analyses of the principal sulphur waters of the United States to the same measure, a wine pint, and tabulated them as follows, for the sake of a ready comparison: (see table on following page).

By reference to the table, the great analogy is at once apparent which exists between the Lafayette water and that of the Kentucky Blue Lick. They contain, with a few trifling exceptions, the same ingredients. The exceptions are the sulphate of potassa and chlorid of potassium, contained in the Blue Lick alone, and the chlorid of calcium, contained above in the Lafayette water. The latter water contains less sulphuretted hydrogen, and carbonic acid, and less solid matter. It is curious that the common salt bears almost exactly the same ratio to the rest of the salts in both waters.

Total Salts.			Common Salt.	
Blue Lick.	Lafayette.		Blue Lick.	Lafayette.
79 :	53	: :	64 :	x=42

The common salt (x,) in the Lafayette waters, is by experiment nearly 41.

In round numbers one and a half pints of the Lafayette water contain as much common salt as one pint of the Blue Lick water. The magnesia salts bear a greater proportion to the rest of the salts in the Lafayette water than in the Blue Lick.

* This is the weight of a wine pint of the artesian water; the weight of the same measure of pure water being 7291·11 grains.

† Equivalent to carbonate of the protoxyd of iron 0·0061 per mille.

Tabular view of the principal Sulphur Waters of the United States. Expressed in grains in the wine pint.

	Name of Springs.	Temperat. F.	Density.	Carbonates. Lime.	Carbonates. Magn.	Carbonates. Bic'b. Mag.	Sulphates. Lime.	Sulphates. Mag.	Sulphates. Potas.	Sulphates. Soda.	Chlorids. Calc.	Chlorids. Mag.	Chlorids. Pot'm	Chlorids. Sodium	Iodid. Magnesium.	Bromid. Magnesium.	Name of analyst.
Sharon, N. Y.	Sulphur Spring, ...						6·98	2·65				0·15		0·14			Chilton.
	Magnesia Spring, ...					3·81	9·50	2·83				0·36*					L. Reed.
Avon, N. Y.	New Spring, ...	50°	1·00356	3·37			0·44	1·01		4·84				0·71			Hadley.
	Middle Spring, ...	51°		1·00			10·50	1·25		2·00				2·30			Hadley.
	Lower Spring, ...	45°–47°	1·0018	3·58	....		7·17	6·21		1·71	1·05						Chilton.
	Sylvan Spring, ...			3·35	2·0		10·05	1·62				7·8		12·18	trace.		Chilton.
Virginia,	Greenbrier White Sulphur,			1·15			7·744	5·588			0·204			0·180			Rogers.
Kentucky,	Blue Lick, ...	62°	1·007	2·957	0·017		4·25		1·117			4·049	0·174	64·107	0·005	0·030	Peters.
Indiana,	Artesian Well, Lafayette,	55°–56°	1·00523	1·503	0·050		7·002				0·465	3·707		40·596	trace.	!	Wetherill.

	Name of Springs.	Metallic Sulphurets.	Oxyd iron, etc., etc.	Silica.	Organic matter.	Loss.	Total grains in a wine pint.	Cubic inches of gas in a wine pint. Sulphuretted Hydrogen.	Carbonic acid.	Nitrogen.	Oxygen.	Name of analyst.
Sharon, N. Y.	Sulphur Spring, ...	0·14†					10·06	1·00				Chilton.
	Magnesia Spring, ...	0·06‡					16·57	0·41				L. Reed.
Avon, N. Y.	New Spring, ...						10·37	3·91				Hadley.
	Middle Spring, ...						17·05	12·00	5·60			Hadley.
	Lower Spring, ...						19·72	1·32	0·50			Chilton.
	Sylvan Spring, ...				0·03		37·03	2·58	0·62	0·67		Chilton.
Virginia,	Greenbrier White Sulphur,		trace.		trace.	0·41	15·276	0·175 to 0·348§	0·25	0·444	0·181	Rogers.
Kentucky,	Blue Lick, ...		0·045	0·137	trace.	2·216	79·104	0·834	5·887			Peters.
Indiana,	Artesian Well, Lafayette,		0·062	0·058	trace.		58·443	0·184 to 0·287	1·525	0·616		Wetherill.

* Chlorids of Magnesium and Sodium.

† Sulphurets Calcium and Sodium.

‡ Sulphurets Calcium and Magnesium.

§ 0·032 by Dr. Hayes' analysis.

The sulphuretted hydrogen of the Lafayette water is equal in quantity to that ingredient in the Greenbrier White Sulphur water of Virginia, and varies as in that water. I established this fact by many and careful sulphur determinations of the Lafayette water by the chlorid of arsenic test upon water taken at the spring. I have also made frequent careful density determinations of the water during a period of six months, and have found the specific gravity invariably to the third decimal point, proving an invariable mineral composition for the water during that time.

The Lafayette water has been used with great success in the diseases for which sulphur waters are applicable.

I have noticed in the neighborhood of this city several chalybeate springs. A very fine one is situated upon the shore of Barnett's creek, which flows through the celebrated battle-ground of Tippecanoe at a distance of seven miles from Lafayette. The temperature of the water was 53° when that of the air was 84°. It strikes a dark color with extract of galls, has a strong chalybeate taste, and coats the stones over which it flows with an ochreous deposit.

Art. XXX.—*On the Measurement of the Striæ of Diatoms;* by W. S. Sullivant and T. G. Wormley.

No characters are so constant for distinguishing the species of diatoms as those drawn from the striæ on their frustules. The accurate measurement of these striæ has not received the attention, particularly among European microscopists on the continent, that might have been expected from the general interest taken in the study of these beautiful organisms.

Attention appears to have been first directed to this subject in Silliman's Journal for 1849–50, by the late distinguished Professor J. W. Bailey of West Point, and Mr. De La Rue of London, in their papers on the marking of Pleurosigma Spencerii, the measurements of which, made by the latter gentleman, remaining to this day a reliable standard for comparison. In 1853 the first volume of Smith's admirable synopsis of British Diatomaceæ appeared, in which the striation of numerous species, is, for the most part, correctly determined. Next in order of time is the paper of Messrs. Harrison and Sollitt, read (1854) before the British Association for the Advancement of Science, giving measurements (widely different from those in Smith's Synopsis) of several well known species.

The above, including the second volume of Smith's Synopsis, embraces about all the information on record, relating to the subject of these papers, known to the writers.

The measurements of the larger portion of the following species were made on authenticated English specimens. The figures affixed to each species express the number of transverse striæ in the $\frac{1}{1000}$th of an inch (·001″), as determined by us; next following and in parentheses are the measurements, if any, of other observers. In not a few cases it will be seen that our measurements accord very nearly with those in the Synopsis, not differing more than might be expected in observations of this kind: besides it is well known that the striation of each species varies within certain limits peculiar to the species. In other cases, however, there are discrepancies between our measurements and those in the Synopsis, too great to be accounted for in this manner.

Nitzschia sigmoidea, 72 to 75; (85, Smith); (105, Harrison and Sollitt).—N. obtusa, 54; (56, S.).—N. plana, 50; (56, S.).—N. linearis, 73.—Stauroneis linearis, 65.—Cocconeis Thwaitesii, 54; (72, S.).—Amphora membranacea, hoop 53, valve 36; (80, S.).—Cymbella cuspidata, 35; (30, S.).—C. Scotica, 45; (42, S.).—Navicula lanceolata, 40; (44, S.).—N. firma, 42; (42, S.).—N. ambigua, 38; (36, S.).—N. sphærophora, 40; (42, S.).—N. lævissima, 51; (48, S.).—N. rhomboides, 70; (85, S.).—Pinnularia Johnsoni, 48; (56, S.).—Fragillaria virescens, 40; (44, S.).—F. Capucina, 40; (40, S.).—Colletonema vulgare, 72 (72, S.).—C. eximium, 56; (56, S.).—Achnanthidium coarctatum, 34; (40, S.).—A. lanceolatum, 33; (40, S.).—Amphipleura inflexa, 52; (52, S.).—A. pellucida: we have not been able even to "glimpse" the striæ on this diatom. Messrs. Harrison and Sollitt in their paper above cited, estimate the striæ at 125 to 130 in ·001″.—Himantidium pectinale, valve 27, hoop 48; (v. 27, h. 48, S.).—Pleurosigma macrum, 70; (85, S.).—P. angulatum, 45 to 50; (52, S.); (75, H. & S.).—P. Spencerii, 48 to 50 tr., 55 long.; (52 tr., 55 long., S.); (120 to 200, Bailey).—P. attenuatum, 36 tr., 32 long.; (40 tr., 30 long., S.).—P. fasciola, 56; (64, S.); (90, H. & S.).—P. littorale, 40 tr., 22 long.; (50 tr., 24 long., S.).—P. acuminatum, 45 tr., 40 long.; (52 tr., 40 long., S.).—P. strigosum, 42; (44, S.).—P. Hippocampus, 38 tr., 32 long.; (40 tr., 32 long., S.).—P. lacustre, 42; (48, S.).—P. quadratum, 45; (45, S.); (70, H. & S.).—P. speciosum, 42; (44, S.).—P. prolongatum, 55; (65, S.).—P. strigile, 30 tr., 35 long.; (36 tr., 40 long., S.).—P. elongatum, 48 to 50; (48, S.); (60, H. & S.).—P. distortum, 60; (75, S.).—P. formosum, 36 tr., one set of oblique striæ 24, the other 30; (36, S.).—P. decorum, 45 tr., 36 oblique; (36, S.).—P. intermedium, 56; (55, S.).—P. Balticum, 36; (88, S.).

—P. Wormleyi, 52.*—P. obtusatum, 56.†—P. Sciotoensis, 40.‡—Synedra radians, var.? a common fresh water species in this vicinity, has on the hoop about 75 striæ in the ·001″, very difficult, when balsam mounted, to resolve, owing probably to their shallowness.—Grammatophora subtilissima, 70 to 75 on the Greenport variety, 75 to 82 on the Providence variety.—Hyalodiscus Californicus: a large valve ·005″ in diameter (the central disc or umbilicus measuring ·0016″) gave at the margin of the umbilicus about 65 straight radial lines in ·001″; midway between that point and the circumference of the valve near 70 in ·001″; and at the circumference about 75 in ·001″. More or less of these lines from the margin of the umbilicus, before reaching the circumference, bifurcate: this accounts for their being coarser near the umbilicus than at the circumference, as is shown by the above measurements, and by the greater ease with which they are resolved near the former point. The umbilicus itself is rayed, and in certain portions of the light exhibits curved lines.

To those interested in these matters it may not be unacceptable to state the means and method by which the above measurements were obtained. The objectives used were two $\frac{1}{12}$ths, one by Spencer, the other by Ross, and a $\frac{1}{16}$th by Powell and Lealand, upon one of Smith and Beck's first-class stands, with their second eye-piece and Jackson micrometer. An important adjunct to the above was Tolles' amplifier which consists essentially of an achromatic meniscus lens placed between the objective and the eye-piece, affording an amplification much superior to that from ordinary eye-piecing. The value of the Jackson micrometer (a scale of ·005″) with each of the objectives was carefully established by the averages of numerous trials on two of Smith and Beck's stage scales of ·001″. Thus the smallest divisions of the Jackson micrometer were made by moderate

* Pleurosigma Wormleyi, Sulliv.—Lanceolatum, conspicue sigmoideum, in apices acutos subito attenuatum; long. ·003″; striis trans. et long. 52 in ·001″.

Fresh water; Columbus, Ohio, *Prof. T. G. Wormley;* Genessee river, N. Y., *Mr. C. A. Spencer.*

Resembles P. Spencerii, but is a smaller species, more evidently sigmoid and with rather abruptly attenuated ends: its striæ are more difficult to resolve, being shallower: texture of the valves thinner.

† Pleurosigma obtusatum, sp. nov.—Oblongo-lanceolatum, leviter sigmoideum, apicibus obtusis; long. ·0025″; striis trans. et long. 56 in ·001″.

Fresh water; Columbus, Ohio: Gambier, O., *Prof. H. L. Smith;* Genessee river, *Mr. C. A. Spencer.*

A very small species remarkable for the obtuse ends. It may be a Colletonema, but we have not observed it in gelatinous envelopes.

‡ Pleurosigma Sciotoensis, sp. nov.—Lineare, modice sigmoideum, in apices obtusiusculos sensim attenuatum; long. ·005″; striis trans. et long. 40 in ·001″.

Fresh water; Columbus, Ohio: Genessee river, N. Y., *Mr. C. A. Spencer.*

Not unlike P. Spencerii, for which it has passed as a variety, but is a larger species, its valve having more parallel sides and less acute ends. Its striation at once distinguishes it. Dry valve pale straw-color.

draws of the draw-tube to measure with different objectives from ·000025″ to ·00000167″ under an amplification of 1700 to 3600 times; precautions being taken against any disturbance of said value, that might arise from the thin glass covering the object. A Powell and Lealand cobweb micrometer was occasionally used, but mostly for corroboration. The Jackson micrometer, upon the whole, was found to be more manageable and satisfactory, the shortness of its lines permitting their coincidence with the striæ to be more readily observed. The light employed was sunlight, admitted through a small aperture into a darkened room: with no other light could the striæ of the highest marked frustules be distinctly resolved under an amplification sufficient for counting. In order to diminish as much as possible the chances of error, the counting always embraced as many contiguous striæ as covered a space equal, at least, to that between the centres of the *five-lines* of the micrometer, and when practicable a larger number was counted.

In conclusion, we may remark that our experiments are confirmatory of the generally received opinion that striæ closer than about 85 in ·001″ have not yet been resolved. Whether this limit is interposed by the physical properties of light, or whether it arises from defects still existing in our apparently faultless instruments, remains to be determined.

Columbus, Ohio, January 18th, 1859.

Art. XXXI.—*Correspondence of Prof. Jerome Nicklès, dated Paris, January 3rd*, 1859.

On the nature of simple bodies.—The Comptes Rendus for December contains a long memoir by Despretz on his researches to ascertain whether certain of the so-called elements are decomposable. His laborious and careful investigations have led to no decomposition, and he announces the conclusion that the substances called elementary are really elementary or incapable of decomposition. The author should have added, that they were not decomposable by the methods he used, for it is not probable that there is nothing more to be done in this branch of research. His process consists in submitting the element—cadmium for example—to the physical and chemical reagents ordinarily employed in analysis. He transforms it into an oxyd, then into salts of all kinds, decomposes these salts by chemical and galvanic methods, precipitates the metal at one time at the positive pole, at another at the negative, examines the crystalline form, turns it again into salts, which he decomposes, vaporizes the metal by means of the pile; and thus causes an element to pass through a great number of different states, and still arrives at the same element. While rendering justice to the zeal and patience of Mr. Despretz, we have to regret that these good qualities have been here wasted,

for the researches would be a hindrance to the progress of science if taken seriously.

Dumas took upon himself the refutation of Mr. Despretz, and brought to the subject his well known ability. He prefaced his remarks by presenting the following table which exhibits an interesting relation between the equivalents of certain simple and compound bodies.

Fl 19	Cl 35·5	Br 80	I 127		Difference 5.
N 14	Ph 31	As 75	Sb 122		
Mg 12·25	Ca 20	Sr 43·75	Ba 68·5	Pb 103·5	Difference 4.
O 8	S 16	Se 39·75	Te 64·5	Os 99·5	
Ammonium 18	Methylamine 32	Ethylamine 46	Propylamine 60, etc.		Diff. 3.
Methylium 15	Ethylium 29	Propylium 43	Butylium 57, etc.		

As this relation suggests a doubt as to the elements being simple, Dumas took occasion to express his opinion on this important question.

Since the radicals (elements) in mineral chemistry present the same general relations as those in organic, he believes there is reason for bringing the two branches more closely together than is usually done. We can decompose the latter, and there is no proof that we may not decompose the former. The following are the conclusions in his memoir which will soon be published.

(1.) The compounds which the three kingdoms offer for our study, are reduced by analysis to a certain number of radicals which may be grouped in natural families. (2.) The characters of these families show incontestible analogies. (3.) But the radicals of mineral chemistry differ from the others in this, that if they are compound, they have a degree of stability so great that no known forces are capable of producing decomposition. (4.) The analogy authorizes the enquiry whether the former may not be compound as well as the latter. (5.) It is necessary to add that the analogy gives us no light as to the means of causing this decomposition, and if ever to be realized, it will be by methods or forces yet unsuspected.

Spontaneous generation.—Mr. Pouchet, Professor of Zoology at Rouen, is a decided believer in spontaneous generation, and has undertaken to revive this theory which has been overturned by the experiments of Schultze and Schwann, as well also by those of Messrs. Schroeder and Dusch. The former have shown that animal substances do not ferment when they are enclosed in air which has previously traversed a red hot tube. The latter state that these same substances may be preserved indefinitely in air which has previously been made to pass through a tube containing cotton. They have alike concluded from their experiments that fermentation and putrefaction are only the results of the life of certain inferior animalcules whose germs were in the atmosphere, and which are developed at the expense of the fermentible substance. Remove these germs either by filtration or calcination and there is no fermentation or putrefaction.

The mechanical theory of Liebig, which has at least as much probability in its favor as the physiological just mentioned, opens a way of explanation independent both of this and spontaneous generation.

The work of Mr. Pouchet was some time since announced, and the great success of the naturalist of Rouen proclaimed. It was stated that

he would surprise the scientific world with a prodigious number of experiments directly opposed to all received ideas.

The following are the results announced. He has seen cryptogams and animalcules to be produced in vessels when every organic germ has been previously destroyed and when the air had been washed in sulphuric acid or had traversed a tube of porcelain heated to a red heat. He has even succeeded in developing organic beings in artificial air and also in pure oxygen.

The details of one of his experiments are as follows. A flask, holding a litre, was filled with boiling water, then hermetically sealed with the greatest precaution, then inverted in a mercury trough; then when the water is cold, it was opened under the mercury and half a litre of pure oxygen introduced. Immediately after was added to it, under the mercury, a small box of hay weighing 10 grams, which had just been raised, in a flask, by means of a stove to a temperature of 100° C. and kept at this temperature for 30 minutes. The flask was then hermetically sealed by the aid of its stopper ground with emery; and to make it sure, when taken from the mercury a coat of varnish and vermilion was put over the aperture.

Eight days afterward, small globules were found in the liquid and on the hay. On opening the flask at the end of ten days, the oxygen appeared to have remained pure. The whitish globules were due to a fungus in tufts which Mr. Montagne, the micrographer, called *Aspergillus Pouchetii.*

A plant is thus developed in a medium from which it was endeavored to exclude every species of organic germ; but the conclusion of Mr. Pouchet is quite too general, as no facts prove that every kind of vitality was destroyed during the exposure of the hay for 30 minutes to 100° C.

Ozonometry in the Crimea.—During the Crimean war, the French army physicians, established three observatories for ozonometric, thermometric and other meteorological observations, morning and evening each day, and also for keeping statistics of diseases and deaths. Dr. Berigny of Versailles has in charge a reduction of the observations, and the following are his conclusions on the subject of ozone.

(1.) The more the ozonometric test papers were colored in the open air, the more numerous were the sick that were taken to each of the hospitals. One of these hospitals was situated at the general quarters at Sebastopol (Observatory No. 1), the second at the south border of the Inkerman plateau (Obs. No. 2).

(2.) The higher the temperature the smaller the number of sick entered and also of deaths.

(3.) At the three observatories, the ozone curve was essentially the same; and (4.) the same was true for the temperature.

(5.) At observatory No. 1, the less the ozone, the greater the number of deaths, whilst at observatory No. 2 it was the reverse.

This is almost the only positive result which science and humanity have derived from that destructive war, which has cost so much money and so many lives.

Dynamoscopy.—Dynamoscopy is a new mode of auscultation, directed towards the examination of sounds hitherto not studied. The author,

Dr. Collongues, examines these sounds in case of a deceased person with an instrument with one extremity on the part to be auscultea and the other at the ear. It is with this instrument that Dr. Collongues supposes he is able to detect the evidence of actual death.

He found this evidence in 1854 in the case of a woman attacked with cholera who was not believed to be dead. Examining about the heart with his dynamoscope, he distinguished a crackling sound which continued even to the tenth hour after death. He followed up this trial with others, and has arrived at the following conclusions respecting this sound.

(1.) After the respiration and the beating of the heart have ceased at death, a crackling sound may be heard which he calls "bourdonnement."

(2.) The sound continues from five to ten hours after death.

(3.) It goes on decreasing from the time of death, and is last perceived about the præcordial and epigastric regions.

The results have been confirmed by observations on animals. It hence results that life continues until the cessation of this sound has ceased, and the cessation is a positive sign of death. This observation offers a means of distinguishing *lethargy* from death, as the sound does not cease in lethargy.

On applying the instrument to the extremity of the fingers, a sound of similar kind is heard which varies with the age, sex, state of health, activity or repose. The crackling is more rapid in children than in adults, and still more so than in aged persons. It is more gentle in woman than in man of the same age, and the crackling sounds ("pétillemens") are in general twice as numerous as those of man. There is also a great difference for different temperaments, and for different seasons and climates.

A singular experiment made with the instrument is to hear a faint and agreeable harmony which is made at the extremity of the fingers of a man asleep, whilst when awake there is only a great discordance in the "bourdonnement." Dr. Collongues supposes that these sounds have their seat in the nerves.

Artificial Caoutchouc.—This substance is obtained by the action of chlorid of sulphur on oils. On adding to oils an excess of this chlorid, they become heated and take a consistence more or less viscous; after some days they harden and become friable. With one part of the chlorid to nine of the oil, there is a lively reaction, chlorhydric acid is disengaged, and it is all changed into an elastic substance like sponge which whitens in the water. The products are insoluble in water, alcohol, ether, oils, and sulphuret of carbon; they are attacked neither by ammonia nor by dilute acids, and are not altered at 150° C.

These facts have been recently communicated to the French Academy and they were regarded as new. They were known by myself in 1848, and the following is a brief statement of the remarks which I have made on the subject to the Academy. "In order to protect the glass stopper of a flask containing chlorid of sulphur from incrustation, I put on it a little oil. I was not a little surprised on the next day to find the coating completely solidified. I soon recognized that the solidification had been caused by the chlorid, and that in general, this compound hardened fatty bodies by modifying them more less. Being then engaged in other

researches* I proposed to myself to take up this chance observation at another time, when I learned by a number of Dingler's Polytechnic Journal for 1849 that the fact had also been observed by Mr. Rochleder. The subject having thus lost for me its special interest, I published it without making any claims of priority.

"Since then, this observation has been taken up by Mr. Gaumond, who, by mixing the chlorid of sulphur with the sulphuret of carbon has made of it several interesting applications. He forms a soft elastic paste, with which he prepares the ink-rollers of printing presses. This was in 1852."

At the same session, Mr. Balard communicated the results obtained in his laboratory by a workman, Mr. Perra, temporarily engaged there; this was in 1853. The following are some of the results:

100 parts of linseed oil with 15 to 20 p. c. of chlorid of sulphur gave an elastic product. With 5 p. c. of the chlorid the oil was thickened strongly without hardening; in this state it is soluble in all liquids which dissolve the oils, which is not true of the other products obtained with the chlorid. On mixing a given weight of linseed oil with thirty to forty times its weight of sulphuret of carbon, and then introducing one-fourth of chlorid of sulphur, the product remains liquid for several days. On applying this liquid to glass, wood, or any other solid body, the sulphuret of carbon evaporates immediately and the solid body is found to be covered with a varnish.

The chlorid saturated with sulphur is preferable to the pure chlorid. To succeed in these mixtures, it is necessary to put the chlorid quickly into the oil, and agitate it, in order to obtain a uniform product. By degrees it becomes heated; the oil hardens more or less according to the proportions of the chlorid of sulphur. It is necessary to operate with only small amounts of chlorid and avoid the elevation of the temperature. When the mixture is perfect, the material is thrown on a polished surface, as a plate of glass: after some minutes, it is done. A corner of the pellicle is detached with the point of a knife and immediately the whole is easily removed. Several layers may be added to one another, moisture being avoided at the moment of the operation.

Mr. Perra has in this way made small boxes and the handles of knives. By inserting a metallic cloth between two plates of this hardened oil, he has obtained plates that were quite durable. With some precautions, the plates may be made transparent and unalterable in the air; for this end, it is only needed to place them in a stove in order to expel the excess of chlorid. Cold renders the products hard and brittle.

Mr. Perra has not succeeded in making a substance analogous to hardened caoutchouc. He has colored the material or veined it like marble; and for this purpose the coloring material is mixed with the oil before the chlorid is added.

These products made from vulcanized oil are inconvenient for use, as they retain for a long time a disagreeable odor. They are not acted upon by dilute acids or alkalies. In the concentrated state, the alkalies sapo-

* On the cause of the variation of angles in crystals, and on the isomorphism of homologous compounds. See Comp. Rend. Acad., 1848, and Comp. Rend. Trav. Ch. de Laurent et Gerhardt, 1849.

rify them. At 120° C. they become brown, and at a higher temperature they melt with a black color. For moulding, the material is excellent. It is in a high degree electric, and may be used for making electrical plates or the electrophorus. It readily destroys any tissues to which it may be applied.

Bromid of sulphur has properties analogous to those of the chlorid.

Photochemical experiments.—We have more than once had occasion to speak of Niepce de St. Victor, of the military ranks, who employs his leisure in the useful arts. If it shall be demonstrated that there is a fluid analogous to that of caloric and light, presiding especially over chemical phenomena, Niepce de St. Victor will have had a prominent part in the discovery. But a few months since, he ascertained the fundamental fact that a body which had been exposed to solar radiation could act in the dark at a distance on certain bodies, like light which emanated directly from the sun. The observations were made mostly with a cylinder of white pasteboard. Mr. Niepce has just noticed that the pasteboard that has been exposed to the sun, and then has been preserved in the dark in a cylinder of sheet tin (tinned iron), is still active six months afterward. This action of the chemical fluid calls to mind radiant heat.

Nitrate of uranium has in a high degree the property of magazining the chemical fluid. On exposing to the sun, under a photographic proof, paper impregnated with nitrate of uranium, and then at the end of a quarter of an hour, plunging it into a solution of nitrate of silver in the dark, a positive image immediately appears having the usual maroon tint. To fix it, it is only necessary to wash it with pure water. If the nitrate of silver is replaced by chlorid of gold, the image appears of a deep blue. These pictures resist the action of the cyanid of potassium, even on ebullition; they are therefore far more stable than photographs taken in the ordinary way.

Tartaric acid has this same property, although in a less degree. Heat increases the sensibility of the reaction. For on covering with a plate of iron heated to 50° C. both the pasteboard which bears the impression from the sun and the leaf of sensitive paper prepared with chlorid of silver, the image will appear at the end of a few minutes, while at 0° C. it requires several hours to obtain a faint impression.

One general result of the researches of Mr. Niepce is this, that the bodies which preserve the greatest activity with a dose of the sun are, with the exception of the salts of uranium, those which are the least disposed to fluorescence.

This chemical activity which certain bodies may contract under the influence of the sun's rays or *insolation*, is greater or less according to the nature of the substance; it has its limits; when a substance has reached its maximum of activity continued exposure does not add anything to it.

Paper prepared with the nitrate of uranium changes color in the light and becomes insoluble; in the dark it is decolorized, and it becomes soluble after some hours, to be colored again in the light. It reduces the salts of gold and silver, so much as to become colored and insoluble.

A body rendered active by the sun will transmit this activity by contact in the dark to another body—tartaric acid, for example.

Mr. Niepce proposes to investigate whether the permanent activity communicated to a body by the solar rays is capable of determining the combination of chlorine and hydrogen, and whether it can be acquired in a luminous vacuum. An engraving wet and subjected to the sun reproduces itself on sensitive paper. But if it is covered with some millimeters of water, the effect fails, even with a solution of a salt of uranium or tartaric acid.

After having shown that certain bodies acquire by exposure to the sun, the property of reducing in the dark, salts of gold and silver, Mr. Niepce observes further that the reduction does not take place without the intervention of an organic substance. Paper is very good for this purpose, while no action is obtained if we take, for example the edge of a porcelain plate which has just been broken; on impregnating this edge with a solution of nitrate of uranium, no effect is obtained in the sun; but there is an action if we put on the edge a solution of nitrate of silver, containing a little starch or gum, and then sulphate of iron or gallic acid; a coloration is seen in the part subjected to the sun; it is the same if silver be used in place of uranium.

The reagents which Mr. Niepce employs by preference for demonstrating this action of the light are the salts of gold and silver, tinctures of litmus and turmeric, iodid of potassium for paper prepared with starch. In many substances that have been exposed to the sun the activity communicated is apparent in the insolubility; it is on a similar principle acquired under the sun's action by gelatine containing bichromate of potash, that Mr. Talbot has founded his photoglyphy. Heat and humidity promptly cause the loss of this property.

Mr. Niepce cites many examples in which the same results are obtained on inverting the course of operations; thus, a leaf of paper impregnated with gallic acid and exposed to the sun, treated by iodid of potassium, gives a feeble image which becomes very decided if subjected to nitrate of silver. A sheet of paper impregnated with chlorid of mercury and exposed to the sun gives an image with chlorid of tin, chlorid of sodium, soda, potash, and sulphuret of sodium. In the same manner a sheet impregnated with chlorid of tin, and exposed to the sun, gives an image with sulphuret of sodium, chlorid of mercury, chlorid of gold ($Cl^3 Au^2$) and nitrate of silver. A multitude of important facts are still to be drawn from the recent works of Mr. Niepce and we shall return to them again.

Reproduction of engravings by means of Phosphorus.—The engraving is exposed to the vapors of phosphorus burning slowly in the air; the black parts alone become impregnated with the vapors; it is then applied to a sheet of sensitive paper prepared with chlorid of silver; after a quarter of an hour of contact, the engraving is represented on the paper by a design formed of phosphuret of silver, which when it is sufficiently decided, resists the action of dilute chemical agents.

The best way of operating consists in placing the engraving in a box in front of a piece of pasteboard whose surface has been rubbed with a stick of phosphorus, and which covers one of the sides of the box. It is necessary to rub the pasteboard with phosphorus at each operation, because if the phosphorus becomes red phosphorus, it produces no effect.

Chemical nomenclature; making of new words.—To French men of science, or at least to those who seek to discover facts and new substances or species, it is a subject of gratulation that a French-and-Greek dictionary has recently been published. This dictionary is issued by the publishing house of Hachette. Its authors are three Greek scholars, of the highest merit, Messrs. Alexandre, Inspector general of the University, Planche and Defauconpret, Professors. There is also a complementary work—a Græco-French Dictionary by Mr. Alexandre alone.

Bibliography.—At MALLET-BACHELIER'S, Quai des Augustin, Paris. *Traité d'Optique physique*, par M. BILLET, Prof. in the Faculty of Sciences at Dijon, tome I.—This work is altogether mathematical, and one of the kind has long been needed in France. Prof. Billet, with whom the higher optics is a specialty, has here published the results of 20 years of labor. The volume has already gone into the hands of all opticians and professors of physics.

Cours de Physique de l'Ecole Polytechnique, par M. JAMIN. Tome I, with 270 figures and a steel plate.—Mr. Jamin is Professor in the Ecole Polytechnique, and in this work he presents the programme of the course of physics in this celebrated school. From the range of the work it might well be entitled a General Treatise on Physics, for not only are the different topics profoundly treated, but also experimental demonstrations come to the aid of the theoretical and mathematical.

At HACHETTE'S, Rue Pierre Sarazin, Paris.

Résistance des Matériaux, 1 vol. in 8vo., 2d ed.—The first edition of this work appeared in 1853, and has been rapidly exhausted. Before preparing the second, its author, General MORIN, Director of the Conservatory of Arts and Trades, desired to verify by experiment the principal theories, and to this end has made many trials to test the accuracy of the hypotheses admitted in the ordinary theory with regard to the resistance of solids to flexure. He has also experimented on the resistance of sandstone to pressure, on which subject he gives an abstract of the trials made by the French engineer, Mr. Michelot, on the resistance of stones employed for construction at Paris.

Précis d'Agriculture théorique et pratique, par MM. PAYEN and RICHARD. 2 vols. in 8vo.—Among its topics, this work reviews the most recent discoveries on the principal points in the culture of land, besides being an elementary treatise on all departments of agriculture and even Zootechny, a science in which M. Richard is authority, as we had occasion to remark when announcing his "Dictionnaire raisonné d'Agriculture."

Problèmes de Mathématiques et de Physique, par M. MENU DE ST. MESMIN. 1 vol. in 8vo.—This is a volume of exercises prepared with reference to students in the Department of Engineering including Mines, Bridges, Roads, etc. The problems are followed with solutions and explanations, and are illustrated by many figures in the text.

Dictionaire Grec-Français, et Français-Grec. 2 vols., grands in 8vo.—This work is noticed above.

Dictionnaire des Cotemporains, par M. VAPPEREAU, grand in 4° de 1800 pages en 2 colonnes.—In this work, the author proposes to give a biographical notice of the most distinguished cotemporary men in all de-

partments of science, art, industry, literature, politics, and even war. This colossal work remains in the 'state of composition' from the beginning to the end, and therefore open to emendations, until the moment of publication. Supplements will be published as may be required. The whole dictionary is so put together as to admit of modifications, which must be numerous; for the good faith of the author has been more than once surprised.

This dictionary is not addressed only to the French, for men of all lands have a place in it; and the American reader will find a biographical notice of the principal men of the State, Art, Literature and Science in the United States.

Les Philosophes Français au 19e siècle, par Taine, in 12-de 368 pages. —This work is written with much spirit, and in a style both elegant and well adapted in our view for the scientific criticism it contains.

Descloizières.—*Vie et Inventions de Philippe de Girard*, broch. in 12mo, avec figures.—Philippe de Girard was the inventor of the machine for spinning linen thread, and the author of many other inventions, well exhibited and appreciated in this small work.

SCIENTIFIC INTELLIGENCE.

I. CHEMISTRY AND PHYSICS.

1. *On intermitting fluorescence.*—J. Müller has observed in platinocyanid of barium a peculiar phenomenon to which he has given the name of intermitting fluorescence. When a strip of paper is washed with a solution of the salt in such a manner that on evaporation the surface appears covered with a layer of delicate green crystals and then exposed in a dark room to the spectrum produced by a flint glass prism aided by a lens of long focal distance, almost the whole portion on which the blue rays fall appears blue. In this blue portion however, three isolated green fluorescent bands appear. The middle of one of these bands corresponds to Frauenhofer's line G; the two others lie between G and F. The centres of these bands correspond to the wave lengths $0{\cdot}000462^{mm}$, $0{\cdot}000446^{mm}$, $0{\cdot}00430^{mm}$. From this it appears that rays of these wave-lengths produce fluorescence, while those of intermediate wave-lengths produce none. An uninterrupted green fluorescence begins at that portion of the spectrum which corresponds to a wave-length of about $0{\cdot}000410^{mm}$. No similar phenomenon has hitherto been observed.—*Pogg. Ann.*, civ, 649.

2. *On the increase in the resistance to electrical conduction which depends on temperature.*—Clausius has pointed out a remarkable result deducible from the experiments of Arndtsen on the resistance of metals at different temperatures. Arndtsen had arrived at the result that in the simple metals, with the exception of iron, the resistance increases uniformly with the temperature and that in the different metals the comparative increase is nearly the same. Clausius remarks that Arndtsen's numerical results may be expressed by the formula

$$w_1 = w_0\ (1 + 0{\cdot}00366,\ t),$$

in which w_1 is the resistance at the temperature t, w_0 the resistance at

0° C. From this it would follow that the resistance of the simple metals in the solid state to electric conduction, is nearly proportional to the *absolute temperature.* The author remarks that although this conclusion is not yet fully borne out by experiment, the numbers obtained being only approximate, it may yet be of interest and serve as an inducement to new investigations.—*Pogg. Ann.* civ, 650.

3. *On the expansion of liquids heated above their boiling points.*—Thilorier found in 1835 that liquid carbonic acid between 0° and 30° C., has a mean coefficient of expansion of 0·0142, which is about four times greater than that of air and other gases. Drion has endeavored to generalize this observation, and finds, in fact, that other volatile liquids at temperatures sufficiently above their boiling points, exhibit coefficients of expansion of similar magnitude. The following are the author's results for chlorhydric ether and sulphurous acid. The coefficient of expansion of chlorhydric ether at 0° is according to Pierre 0·00157. According to Drion the apparent expansion of the same liquid is 0·00360 of its volume, at 121° C. upon the average for every degree centigrade. Between 128° and 134° the coefficient is 0·00421 of the volume at 128°, while between 144°·5 and 149°·25 the coefficient is 0·00553 of the volume at 144°·5. The mean expansion of sulphurous acid between 0° and 18° is 0·00193. Between 91° and 99°·5 the coefficient is 0·00368 of the volume at 91°; between 108°·5 and 115°·5 it is 0·00463 of the volume at 108°·5; between 116° and 122° it is 0·00533 of the volume at 116°; between 122° and 127° it is 0·0060 of the volume at 122°. From this it appears that the coefficient of expansion of chlorhydric ether becomes equal to that of a gas at a temperature of about 125° C.; that of sulphurous acid equals that of a gas at about 95° C. Above these temperatures the coefficients increase very rapidly.—*Comptes Rendus*, xlvi, 1235.

4. *On the chemical effects of electric discharges.*—Plücker has published in successive parts, the results of an elaborate and very interesting investigation of electric discharges in tubes containing rarefied gases. For the details we must refer to the original papers, which do not admit of condensation, and content ourselves with giving in the author's own words, the results which are most interesting to chemists.

I. Certain gases (oxygen, chlorine, bromine and vapor of iodine,) combine more or less slowly with the platinum of the negative electrode, and the resulting compounds are deposited upon the surrounding sides of the glass tube. When the gases are pure we approximate in this manner to a perfect vacuum.

II. Gases which are composed of two simple gases (vapor of water, ammonia, protoxyd of nitrogen, deutoxyd of nitrogen, nitrous acid,) are immediately separated into their components, and then remain unchanged, if they do not (as ammonia) unite with the platinum. If one of the gases be oxygen (as in steam and the different oxyds of nitrogen) this gradually disappears and only the other gas remains.

III. When the gases are composed of oxygen and a solid simple substance, complete decomposition by the current takes place but slowly, the oxygen going to the platinum of the negative electrode, (sulphurous acid, carbonic oxyd, carbonic acid). Carbonic acid at first splits instantly

into the lower gaseous oxyd and into free oxygen, which combines gradually with the platinum. Carbonic oxyd gas is then slowly decomposed by the combination of its oxygen with the negative electrode. The results above mentioned, were obtained by means of the so-called Geissler's tubes, which are simply glass tubes of various forms containing rarefied gases, and provided with platinum wires fused into the glass. The electric currents were partly derived from the electric machine, and partly from Ruhmkorff's apparatus. Finally, the results themselves are directly deduced from the prismatic analysis of the light of the simple and compound gases, the spectrum obtained being simple, or composed of two distinct and superposed spectra, according as the discharge passes through a simple gas or a mixture of two.—*Pogg. Ann.*, cv, 67. W. G.

5. *On a new Law of Binocular Vision;* by the Rev. J. Dingle, (Proc. Brit. Assoc., Ath., No. 1615).—The object of the law in question is to obviate the imperfect vision which would sometimes arise from the difference of the pictures in the two eyes. In some cases this difference would lead to great inconvenience and confusion. It sometimes happens, for instance, that in looking at a field of view at some distance, objects considerably nearer are so interposed as to present themselves in the picture formed in one eye and not in the other. Thus, in looking at a landscape, if the finger or any other object is held before one eye, the image of it from the one retina is superposed in the *sensorium* on a part of the landscape formed in the other eye. On mere physical principles, this might be expected to blot out or greatly confuse that part of the landscape upon which it was placed; but upon trial this is not found to be the case, as that part is merely a little dimmer than the rest from being seen only with one eye, but is equally distinct and as truly colored.

By various experiments the author had ascertained that this was the result of a peculiar power of the will, by means of which the mind is enabled, when two different images are superposed in the *sensorium*, to select whichever it pleases, to bring that object into view, and entirely to obliterate the other,—it sees, in fact, whichever it wills to see, and the other image, simply by being neglected, becomes invisible. In ordinary vision, the determination of the image to be seen is effected by the same act of the will which determines the position of the optic axes; but by certain arrangements which were indicated both images may be made to have the same relation to the optic axes; and as the predisposition to select one or the other is thus obviated, it is made indifferent to the mind which of the two images that occupy the same place in the *sensorium* it shall see. When these arrangements are made, it is found that mere efforts of the will can easily bring either the one or the other into view. The importance of this law, which enables the mind to select its image, was pointed out in different cases of ordinary vision. It obviates the difficulty already adverted to, of having two different pictures on the same spot; it has not improbably an important influence in producing the general stereoscopic effect; it also, to some extent, remedies the effect of squinting, by obliterating the picture in the imperfect eye, which could not be else done without shutting it. The effect of the law, in some extraordinary cases, was also noticed, especially in the power of the will to fix images on the sight, as Sir Isaac Newton instances in his own case

(see his life by Sir David Brewster). The author pointed out the great interest of the subject, not only in its practical aspect, but also as having an important bearing on the connexion between mind and matter.

Prof. Stevelly said that in reference to these permanent impressions on the retina so well described in the very interesting letter from Sir Isaac Newton which had been read, he wished to mention a circumstance which occurred to himself this summer, and which he was entirely unable to account for on any optical or physiological principle with which he was acquainted. At the close of last college session he had been in weak health, and had gone out to his brother-in-law's seat in the country for a few weeks. While there he had become greatly interested in the economy and habits of the bees. "One morning, soon after breakfast, the servant came in to say, that one of the hives was just beginning to swarm. The morning was a beautifully clear, sunny one, and I stood gazing at the insects, as they appeared projected against the bright sky, rapidly and uneasily coursing hither and thither in most curious yet regular confusion, the drones making a humming noise much louder and sharper than the workers, from whom also they were easily distinguished by their size; but all appearing much larger in their rapid flights than their true size. In the evening as it grew dark, I again went out to see the bee-hive, into which the swarm had been collected, removed to its stand; soon after I was much surprised to see, as I thought, multitudes of large flies coursing about in the air. I mentioned it to my sister-in-law, who said I must be mistaken, as she had never seen an evening on which so few flies were abroad. Soon after, when I retired to my chamber, and knelt to my prayers before going to rest, I was surprised to see coursing back and forward, between me and the wall, what I now recognized as the swarm of bees, the drones quite easily distinguishable from the workers, and all in rapid whirling motion as in the morning. This scene continued to be present to me as long as I remained awake, and occasionally when I awoke in the night, nor had it entirely faded away by next night, although much less vivid. This was the first instance I had ever heard of moving impressions having become permanently impressed on the retina, nor can I give the slightest guess at the *modus operandi* of the nerve. Notices of fixed impressions, particularly after having been dazzled, are now common enough. The Rev. Dr. Scoresby, at the late meeting at Liverpool, had given a detailed account of some which had presented themselves to him; and a very curious one had occurred to me some years since. I was walking down the streets of Belfast with Sir John Macneill, the eminent engineer, when he said to me—'what has become of my old friend Green, who kept that shop; I see new people have got it.' Turning suddenly to look at the shop indicated, I was completely dazzled by the bright reflexion of the sun shining on the new brass-plate under the window of the shop, so that for some seconds I could see nothing. As we walked on I soon observed before me in the air the words 'J. Johnstone & Co.,' in blood-red characters, which soon, however, changed to other colors. With an exclamation of surprise I stated the fact, and we turned back to see whether or not this was really the inscription on the brass-plate, and found that it was. The optical account of this was simple enough. The retina had been partially paralyzed from

the intense light reflected from the plate, but as I had turned with pain from it instantly, the part corresponding to the black letters on the plate had escaped, and as I walked on the red strong light reflected from surrounding objects on this part became contracted with the darkness, as yet showing itself on all the surrounding parts of the disordered retina; as the retina recovered its tone other colors in succession took possession of the place which at first had been red. Sir J. Macneill then told me that when first he had gone to reside in London, a murder had been found out by a similar circumstance. The murderer, then unknown, had been dazzled by the reflexion of the sun from a bucket of water, which another man was carrying before him, and soon after seeing in the air what he took for a bucketfull of blood going before him, he was seized with such horror that he declared himself the murderer, and disclosed such facts as brought the crime home to him, so that he was convicted and executed."

II. GEOLOGY.

1. *A record of Earthquakes, kept at Hilo, Hawaii;* by S. C. LYMAN, (from a letter addressed to Dr. C. F. Winslow, and by him communicated for this Journal).—*June*, 1833. Two slight shocks during the month.

Oct. 3, 1833.—Two shocks in the night, one quite heavy.

Oct. 13.—A shock at 3 o'clock, P. M., motion quick, up and down.

Feb. 19, 1834.—At 6 P. M. there was a slight shaking of the earth which was almost instantaneously followed by a shock so heavy as to upset some things in the house, throw the cream off from milk standing in pans, and throw water out of a pitcher standing in a wash-bowl. At 9 o'clock in the evening there was again a shaking of the earth which lasted only a few seconds.

May 14.—A heavy shock between 2 and 3 P. M.

Aug. 3.—One at about 4 o'clock, A. M., so heavy as to waken people, and cause them some alarm.

March 23, 1835.—One slight shock at 9 A. M.

March 26.—Three shocks following each other in quick succession at 25 minutes past 6 o'clock A. M.

July 21.—Three shocks during the day.

Sept. 6.—One shock at 2 or 3 o'clock A. M.

June 20, 1837.—A smart shock at 20 minutes before 7 P. M.

Jan. 12, 1838.—A smart shock some time after midnight.

Jan. 29.—Three shocks in pretty quick succession a little past 10 o'clock P. M. The first two heavy, the last slight.

July 9.—A slight shock between 8 and 9 o'clock A. M.

Oct. 16.—A jar merely, accompanied with a noise resembling the discharge of distant cannon.

Nov. 5.—Three shocks during the day, one in the forenoon and two in the afternoon.

Nov. 6.—One shock, a few minutes before 10 A. M.

Nov. 7.—A smart shock at midnight, another at twenty minutes past 3, and another about 4 o'clock A. M.

Nov. 8.—Several shocks during the day, and twelve distinct ones during the night. There were frequent shocks during the day and night for

five days following, and then occasional ones during the month, none of them heavy, some of them accompanied by a rumbling sound, others by a noise like the rushing of water by a ship. There was one quite heavy shock, but I do not recollect the time.

Dec. 4.—A distinct though not heavy shock.

Dec. 9.—One shock at 40 minutes before 12 at noon.

Dec. 10.—One shock at 4 o'clock, A. M.

Dec. 12.—A severe shock at 1 o'clock P. M. Stone walls were thrown down, and plastering a good deal cracked, but no other damage done.

April 7, 1839.—A pretty smart shock at midday.

Feb. 1, 1840.—A severe shock at half past 1 P. M.

May 5.—A slight shock at 4 P. M.

Sept. —.—A shock at 10 P. M.

Oct. 14.—A slight shock between 8 and 9 o'clock P. M.

Dec. 18.—Two smart shocks about 5 A. M., waking us from our slumbers.

March 11, 1841.—Two shocks, one at fifteen minutes before 1, the other at 20 minutes before 2 P. M. The motion was up and down, gentle and easy.

April 5.—A smart shock at 15 minutes past 1 P. M., undulations north and south.

April 7.—At 11¾ P. M. This was the most severe shock we have ever felt. Stone walls thrown down, plastering cracked, and chimney also, milk was thrown out of the pans and water out of a pail a little more than half full. Motion undulating north and south. In just one hour there was a trembling of the earth, and after another hour another jar.

May 28.—A shock at half past 7 P. M., not heavy.

June 26.—A shock in the night.

July 3.—A shock between 5 and 6 A. M.

Sept. —.—A smart shock in the night.

Nov. 28.—A shock in the night.

Feb. 14, 1842.—A shock at 5 o'clock A. M.

May 15.—A shock in the night.

Aug. 31.—A shock at half past 9 P. M., not heavy.

Nov. 9.—A shock in the night so heavy as to awaken us.

March 8, 1843.—A shock at 7 o'clock P. M.

April 27.—A shock in the night.

July —.—Two shocks during the month. One in the night, or P. M.

Dec. 15.—A shock at 10 A. M.

Feb. 18, 1844.—A severe shock at half past 6 P. M.

Sept. 1.—A heavy shock between 7 and 8 A. M.

Dec. 21, 1845.—A moderate shock in the night.

Feb. 14, 1846.—A slight shock at 7 A. M.

June 15.—A moderate shock in the night.

June 24.—Ditto.

March 29, 1847.—A shock between 9 and 10 A. M.

Oct. 4.—A heavy shock about 3 o'clock P. M.

Feb. —, 1848.—A heavy shock at 5 o'clock P. M.

April 19.—Two slight shocks about 8 P. M.

July 9.—A severe and protracted shock at 4¾ A. M.

Dec. 5.—A slight shock at 8¼ o'clock A. M.

In 1849, none.

In 1850, only two shocks during the year.

Jan. 12, 1851.—A smart shock at 7 P. M. Premonitory shock, very distinct.

May 4.—A moderate shock after midnight.

May 11.—A slight shock at 2 o'clock A. M.

July 14.—A heavy shock at 20 minutes past 10 A. M.

Aug. 21.—A moderate shock towards morning.

March 31, 1852.—A very severe shock at 1½ P. M.

Oct. 19.—A smart shock at 4¾ A. M.

March 2, 1853.—A smart shock at 5 o'clock P. M.

March 8.—A slight shock.

March 11.—A smart shock at 4½ o'clock A. M.

Aug. 26, 1854.—A smart shock at 4 o'clock P. M.

Oct. 29.—A smart shock at about 8 P. M. Premonitory, distinct.

March 18, 1855.—A smart shock at 8½ P. M. Vibrations continuing several seconds.

May 24.—A protracted tolerably smart shock at about 9 A. M.

June —.—A smart shock at 4½ P. M.

Aug. 3.—A tolerably smart shock at 8½ P. M. Motion up and down.

Sept. 17.—A shock at 8 A. M.

Nov. 2.—A smart shock at 7 A. M.

Jan. 8, 1856.—A smart shock at 4 o'clock A. M.

July 8, 1857.—A slight shock at 5½ o'clock, A. M.

July 30.—A severe shock at 1 A. M. Motion undulatory.

Aug. 30.—A slight shock at 1½ P. M.

Sept. 9.—A short smart shock at 9 o'clock A. M.

March, 1858.—One slight shock, time not recorded.

April —.—A protracted and rather heavy shock in the night.

June 8.—A slight shock at 3 P. M.

July 5.—A smart shock or jar at 2 A. M.

This record has been kept simply for my own gratification, and consequently is not in as good a form as it might have been could I have known that it would ever have been needed for scientific purposes. As a general thing I noted down the earthquakes as they occurred. When they have come in the night I have not always known the precise hour, and when I have been sick the day of the month has sometimes been forgotten. This must account for the imperfect manner in which my record has been kept. I shall endeavor to be more particular in future.

I would here remark that our earthquakes are never very protracted, seldom lasting over a few seconds, and they are seldom violent, though generally sufficiently so to shake our nerves.

Hilo, Hawaii, Sept. 11, 1858.

2. *Hadrosaurus Foulkii, a new Saurian from the Cretaceous of New Jersey, related to the Iguanodon,* (from the Proceedings of the Acad. Nat. Sci., Philad., 1858, p. 213.)—Mr. Wm. Parker Foulke made a statement respecting the fossil bones, shells and wood presented by him to the Academy this evening.

Passing the summer and autumn at Haddonfield, Camden County, New Jersey, Mr. Foulke learned that one of his neighbors, Mr. John E.

Hopkins, while digging marl upon his farm, about twenty years ago, had found some bones. These were described as vertebræ, and as being of large size, and very numerous. Mr. Hopkins being young at the time of the discovery, and not specially interested in such subjects had permitted visitors to carry away the fossils; so that none remained in his own possession, nor could he remember the names of any of the persons by whom the vertebræ had been taken. According to his recollection, no head had been found, nor any other bones than those of the spine, except one, which was said by him to have resembled in general respects, a "shoulder blade." It appeared then, not improbable that upon digging around the old pit, (which was sixteen feet long and eight feet wide,) a head, or at least a portion of one containing teeth, might be obtained. Considering the geological age of the formation upon which Haddonfield stands, and that specimens of Mosasaurus had been discovered in places not very remote from the village, there appeared sufficient motive for exploration. Mr. Hopkins with an intelligent appreciation of the object proposed, gave to Mr. Foulke, with prompt liberality, permission to dig in any part of the farm, and to take away whatever fossils might be thus procured. There was some difficulty in ascertaining the place of the old excavation. It had been made in the bed of a narrow ravine, in which a brook flows eastwardly into the south branch of Cooper's Creek; but the pit had long since been filled to the common level of the bed, and it was in like manner overgrown with grass, shrubs, and young trees, so as to be undistinguishable by the eye. After conference with one of the diggers who had been employed at the time of the discovery, (whose indication proved to be inaccurate,) and after a careful survey of the vicinage by Mr. Hopkins, a party of experienced marl diggers were set at work; and after one day's preliminary trial, the eastern side of the old pit was detected. In conformity with Mr. Hopkins's recollection of the manner in which the vertebræ lay, the party of diggers was shifted to the western side of the old pit. The superficial deposit overlying the marl here, was only about four feet thick; the ravine being between twenty and thirty feet deep. At nearly four feet further depth, a thin stratum of decomposed shells was passed; and at about two feet below this, overlying and intermixed with another stratum of shells, the workmen came upon a pile of bones—the same now before the Academy. The total depth from the surface was between nine and ten feet. * * *

Dr. Leidy stated that the bones, mentioned in the remarks of Mr. Foulke, obtained from the marl of Mr. Hopkins's farm, near Haddonfield, New Jersey, and now exposed to the view of the Society, were those of a huge herbivorous saurian. The animal was closely allied to the great extinct *Iguanodon* of the Wealden and Lower Greensand deposits of Europe; the genus is, however, different, and for it the name of *Hadrosaurus*, is proposed.

Besides a number of small fragments, the bones consist of twenty-eight vertebræ, mostly with their processes broken away; a humerus, a radius and an ulna, complete; an ilium and a pubic bone, imperfect; a femur, a tibia and a fibula; two metatarsal bones and a first phalanx, complete. There are also in the collection nine teeth and a small fragment of the lower jaw.

The bones are ebony black, from the infiltration of iron, and are exceedingly heavy. Their texture is firm and well preserved; and they are neither crushed nor water rolled. In association with them, besides the shells and wood, were found several teeth of *Odontaspis* and *Enchodus.*

Most of the specimens of teeth of the *Hadrosaurus* appear to have belonged to the lower jaw. These, when unworn and perfect, are about two inches long, and of all known teeth mostly resemble those of the *Iguanodon.* They have a demi-conoidal crown, with a lozenge-shaped enamel surface directed inwardly, and divided by a prominent median carina. The upper borders of this surface are provided with short, transverse, tuberculated ridges. The body of the crown outwardly is paraboloid in transverse section, and is prolonged into a laterally compressed conoidal fang. As the teeth were worn away from the summit, their gradually expanding triturating surface sloped downward and outward. This surface is shield-like in outline, is bordered by enamel internally, and crossed by a slightly elevated crucial ridge with diverging branchlets. The ridge, resulting from the latter ossification of the dental pulp, is harder than the surrounding dentine, and is adapted to retain a rough triturating surface. The sides and bottoms of the teeth exhibit the impressions of lateral and inferior successors, and appear to indicate that the teeth in use, together with those more or less developed within the jaw, had a quincuncial arrangement.

Two of the specimens of teeth perhaps belong to the upper jaw. They differ from the others in the extraordinary degree of development of the median carina of the crown. The enamelled surface was perhaps directed in a reverse manner to that of the lower teeth; that is to say, outwardly. It is likewise lozenge-like in outline, and tuberculated at the lower borders. The body of the crown inwardly is half oval in section. The fang for more than half its width is prolonged from the carina of the crown. These teeth also exhibit the impress of successors holding the same relative position with one another as in the lower teeth.

The fragment of the lower jaw is a portion of the left dentary bone, and is three inches in depth. It has an outer parapet wall about two inches high, with deep vertical grooves for the support of the teeth. No corresponding wall appears to have existed on the inner side of the latter.

The cervical vertebræ have their bodies prominently convex in front and deeply concave behind, and would appear to indicate that Mantell was correct in assigning similar vertebræ, found in the Wealden deposits of England, to the *Iguanodon.* Three cervical vertebræ, suspected to be the third, fourth, and fifth, are two and a half inches long at the sides.

Five succeeding vertebræ, not immediately conjoining the ones just mentioned, and supposed to be anterior dorsals, likewise have convexo-concave bodies. At the sides of the latter they are from 3 to 3½ inches long, and posteriorly are 3½ inches wide. The sides of their arch present a deep pit for the articulation of a rib; but no articular mark is perceptible at the sides of the bodies. Two other vertebræ, perhaps posterior dorsals, have the bodies slightly prominent in front and slightly concave behind; and they are 3½ inches long at the sides, and 4¾ inches wide posteriorly.

The caudal vertebræ possess articular surfaces for chevron bones; and the specimens we possess, from different parts of the tail, give the following succession of measurements of their bodies: length 2½ inches, breadth 5 inches; length 3 inches, breadth 4½ inches; length 3 inches, breadth 3½ inches; length 2¾ inches, breadth 2¼ inches; length 2½ inches, breadth 1¾ inches. From the gradation of size of seventeen specimens in the collection, it may be estimated that there were originally about fifty vertebræ to the tail. This number may be too great by about ten, but certainly not more.

A caudal vertebra from near the middle of the tail has its arch and spinous process complete. The two latter together measure 11 inches long from the body, which is 4½ inches deep. The addition of a chevron bone would indicate the tail of the animal, at its middle, to have been between one and a half and two feet in depth.

The *humerus* is perfect, and is 23 inches long. Its breadth at the tuberosities, between which the head projects midway, is 7 inches. The shaft above is compressed from without inwardly; its lower part is cylindroid, and near the middle of the bone measures 9¾ inches in circumference. At the condyles the transverse diameter is 5¼ inches. Only a very short and narrow medullary cavity occupies the centre of the shaft.

Both bones of the fore-arm are solid. The *ulna* is 23 inches long, and 7 inches in circumference at the middle. The *radius* is 20 inches long, and 6 inches in circumference at the middle.

A very great disproportion exists between the bones of the fore and hinder extremities. So much is this the case, that I was at first inclined to believe they belonged to different animals. The disproportion is even greater than in the *Iguanodon*, as indicated by comparison with the remains of an individual of the latter, in the British Museum, known as the Maidstone specimen.

The *ilium* has its two extremities broken away, and in its present condition is 27 inches long. Its sacral articular surface is 12 inches long by three inches thick. The breadth of the bone, opposite the latter surface, is from 7 to 9 inches. A bone, which I suspect to be the *pubic*, but which appears to correspond with that of the Maidstone *Iguanodon* described as the clavicle, is 26 inches long in its present state; one end being broken away. The remaining pubic extremity is 10½ inches wide.

The *thigh bone* is 40 inches long; its breadth at the head and adjoining trochanter is 9 inches; its breadth at the condyles is 8 inches; and the antero-posterior diameter of the internal condyle is 10 inches. The shaft is quadrate, and provided at its middle portion internally with a large trochanter. The circumference of the shaft just above the latter is 17 inches; just below it, 15 inches. The condyles in front enclose a large foramen terminating a groove descending from the shaft. Posteriorly, at the bottom of the intervening notch, they enclose a smaller foramen. The medullary cavity is of large size, and extends about half the length of the shaft through its middle portion.

The *tibia* is 36½ inches long; its breadth at the upper part is 11 inches; and its breadth below is 10 inches. Its shaft is narrow and cylindroid at the middle, where it measures 11¾ inches in circumference.

From this position it rapidly expands towards the two extremities of the bone. The medullary cavity is very short and narrow.

The two *metatarsal bones* are of robust proportions and are each about 11 inches long. The *proximal phalanx* of a toe is 6 inches long, and 5½ inches broad at base.

If we estimate the number of vertebræ of the trunk of *Hadrosaurus*, to have been the same as in the recent Crocodile and Iguana; the number of sacral vertebræ to have been the same as in the *Iguanodon;* and the number of caudal vertebræ to have been fifty; the whole number of vertebræ would have been eighty. A calculation of the length of the specimens of vertebræ in our possession, with a proper allowance of separation by intervertebral fibro-cartilages, and an addition of two and a half feet as an estimate of the length of the head, would give, as the total length of the animal, about *twenty-five* feet.

The great disproportion of size between the fore and back parts of the skeleton of *Hadrosaurus*, leads me to suspect that this great extinct herbivorous lizard may have been in the habit of browsing, sustaining itself, kangaroo-like, in an erect position on its back extremities and tail. As we, however, frequently observe a great disproportion between the corresponding parts of the body of recent and well known extinct saurians, without any tendency to assume such a position as that mentioned, it is not improbable that *Hadrosaurus* retained the ordinary prostrate condition, progressing in the manner which has been suspected to have been the case in the extinct batrachian of an earlier period, the *Labyrinthodon*.

Hadrosaurus was most probably amphibious; and though its remains were obtained from a marine deposit, the rarity of them in the latter leads us to suppose that those in our possession had been carried down the current of a river, upon whose banks the animal lived.

Occasionally uncharacteristic fragments of huge bones have been found in the green sand of New Jersey, (of which we have several in the collection of the Academy,) which I suspect to belong to *Hadrosaurus*. One of these specimens exposed to the view of the members, indicates a much larger individual than the one whose remains have been presented this evening.

The species I would respectfully propose to dedicate to our fellow member, W. Parker Foulke, than whom none of our number is more zealous in the advancement of the great objects of this Academy.

3. *Ichnology of New England:* A Report on the Sandstone of the Connecticut Valley, especially its Fossil Footmarks, made to the Government of the Commonwealth of Massachusetts by Edward Hitchcock, Professor in Amherst College. 220 pages 4to, with 60 quarto plates.—Professor Hitchcock has here given us a revision of his labors on the subject of the Connecticut River Footmarks, in which he has so long and successfully labored, and, besides, has added a large amount of new material and many fine plates in its illustration. The volume opens with a bibliography containing a list of all publications on American Fossil Footprints. The characters, conditions, and origin of the strata are then discussed, and following these pages, the descriptions of the various fossil imprints.

On the age of the sandstone Prof. Hitchcock concludes: that the upper half of the sandstone,—that east of the trap range of Mount Tom,

—is not older than the Lias; and that the Virginia and North Carolina beds are of equivalent age; the lower half of the same sandstone, which may be a mile in thickness, according to the measurements of Prof. H., are thick enough to embrace the Triassic and Permian; but no evidence has been obtained that the Permian is represented.

Since the discovery of the Permian in the west as a direct continuation of the Carboniferous beds, and as the closing part properly of the Carboniferous system, it has become more apparent, we think, that the beds on the Atlantic border from the Connecticut valley to North Carolina, belong to a later period. The elevation of the Appalachian mountains appears to have closed the Palæozoic era, and thus separates the Permian period, the last of the Carboniferous age, from the Triassic, the first of the Reptilian. The observations of Prof. Hitchcock tend to confirm this view, for the rocks all appear to belong to one system: the fossils of the upper half are as recent probably as Lias; and no trace of a Permian species has been found in any of the beds.

The footprints are referred to Marsupialoid animals (5 species); Birds (31 species); Ornithoid reptiles, or reptiles walking on their posterior feet (12); Lizards (17); Batrachians (16); Chelonians (8); Fishes (4); Crustaceans, Myriapods and Insects (19); Annelids (10)—in all 123 species, more than double the number announced ten years since. The reference of some of these species to the special division in which they occur is still quite doubtful, as Professor Hitchcock states, especially the Chelonian and Marsupialoid tracks. It is not possible to present the arguments respecting them satisfactorily in a brief notice, and they would be imperfectly appreciated without figures; we therefore refer our readers to the work. The question whether any of the tracks were made by birds has seriously come up, since it has been found that some species (placed among the Marsupialoids in the work, but probably Reptilian) had 3-toed bird-like hind feet, and hand-like fore feet. The descriptions of the species are given with much detail and illustrated by characteristic figures, which enable any that are interested to pursue the subject and work out their own conclusions, where those of the author are not deemed satisfactory. It is quite possible that some of the genera of reptiles are identical with those that have been made out from fossils in Europe. Much is to be learned respecting the tracks of living animals, and the variations for running, walking and standing, before the subject will be exhausted.

The Ichnological Cabinet at Amherst contains a magnificent display of specimens, and if Professor Hitchcock had done nothing more than collect this cabinet, he would have made his mark on the science of geology. In pronouncing the display magnificent we speak advisedly. The Cabinet is by no means fairly treated in a sketch on one of the plates. The hall is 100 feet long and 30 wide; and it is filled from one end to the other with slabs of various sizes, some eight feet and upwards in length. Of the huge Brontozoa and Otozoa there are many specimens; and one series of the latter of eleven tracks covers a slab 30 feet long. The hand-like hind feet of the Otozoum are 20 inches long. There are a few tracks of the fore-feet of this biped batrachian (?) which are a little less than half the length of the hind feet; they show that the ani-

mal sometimes brought its anterior limbs to the ground though generally walking on the posterior pair.

The delicate tracks of insects or crustaceans are also remarkable. There is a specimen with impressions of what appears to be a neuropterous larve, although of doubtful relations. The Cabinet contains specimens of all the species that have been discovered in the Connecticut valley. The number of tracks on all the specimens collectively is not less than 8000, averaging 68 tracks for each species.

4. *Geological Survey of Canada.* Report of Progress for 1857. 240 pp., 8vo. Toronto, 1858. Sir W. E. LOGAN, Geologist.—This valuable Report includes notices of the Laurentian rocks about the mouths of the French River, the Huronian and other rocks of Echo Lake, and the limestone of Bruce Mines, by A. Murray, Esq.; on the Magdalen river and Lake St. John and its deposits, by James Richardson; on the modern fauna of some localities, by R. Bell; on Canadian Graptolites, by James Hall; Palæontological Report by E. Billings; on the composition of some Dolomites, and the origin of magnesian limestone, and on Fish manure, by T. S. Hunt; and an abstract of telegraphic observations for longitude, by Lieut. E. D. Ashe, R.N., with maps, and wood-cuts illustrating the different topics.

Mr. Richardson states in his report on Lake St. John, that recent shells (Saxicava rugosa) occur on Belle river half a mile below the falls, (near lat. 48½° and long. 71½°,) at a height of probably 200 to 300 feet above the sea; also on River St. Alphonse, about four miles above its entrance into the upper part of Ha-Ha Bay, about 150 feet above the sea. The recent researches of Mr. Hall on Graptolites have already been noticed in this Journal. Mr. Billings describes new species of corals, and new genera and species of bivalves from the Silurian of Canada, illustrating several of the latter by figures; and besides he presents important comparisons between the rocks of Canada and New York. The researches of Prof. Hunt on dolomites are of much interest, and we propose to cite from them in another number.

5. *The Quarterly Journal of the Geological Society of London*, vol. xiv, Part 4, No. 56.—This new number contains the conclusion of the annual address of the President, also the important papers reviewing the Geology of the United States by Dr. J. J. Bigsby, (which, were it not for their great length, we should be pleased to reproduce in this Journal,) and a paper by Mr. H. C. Sorby on the microscopic structure of some crystals, besides other shorter papers.

We cite here the conclusions to which Dr. Bigsby has arrived, without wishing to endorse all as they stand. They relate to the central Palæozoic basin or area of Middle North America. They are in part similar to what has before been presented in this Journal and elsewhere, by other writers.

1. That, whatever may be the case elsewhere, the Silurian and Devonian systems of New York are parts of one connected and harmonious period—the product of successive and varying Neptunian agencies, operating in waters which deepened westward from the Atlantic, and southwards from the Laurentine chain on the north.

2. That from the Catskill group (Old Red Sandstone) downwards through the whole series, to the Potsdam Sandstone, there is perfect and close conformability, and no such unwonted change in fossil life as to constitute a *systematic* break, except at one place—the Oriskany Sandstone, the base of the Devonian in New York,—there being no break of like importance at the Oneida conglomerate period, contrary to an opinion towards which able geologists are now inclining,—an opinion which leads them to consider the break at the Oneida conglomerate as systematic.

3. All the palæozoic groups of New York slowly pass one into the other by gradation of mineral and organic characters, with easily explained exceptions.

4. The palæozoic strata of New York are comparatively thin. They seem to have lost in thickness what they have gained in extension.

5. De Verneuil rightly divides the New York groups into two great classes,—the "constant" and the "local." Among the former are Potsdam Sandstone, Trenton Limestone, and Niagara. Among the latter are the four lower Helderbergs, and perhaps Oneida conglomerate, &c. This is a useful division.

6. That it is both convenient and natural to divide the Silurian and Devonian systems of this State each into three stages,—the division being based on change of sediment and their fossil contents.

7. The Middle Silurian stage is a period of especial transition—from the coarseness of some of its sediments, from their innumerable and minute alternations, and from the organic poverty prevailing.

8. That the presence of Oneida conglomerate in New York does not necessitate a change of name for all the strata below it (of "Cambrian" for instance;) because a conglomerate does not always indicate *systematic* change,—not even if there be volcanic intercalation, provided there is conformableness, and some community of fossils.

The Oneida conglomerate seems to be local, is supernumerary, and only found at present on the east of Middle North America.

9. The hardening and crystallizing effect of metamorphism is seen only in the neighborhood of hypogene rocks.

10. The New York basin exhibits few uplifts, and those of limited magnitude; no uplifts dividing it into a series of deep basins contained in hypogene beds, as in Bohemia, Wales, &c. Neither has it sheets of alternating volcanic grit (conformable,) save in the Potsdam rock on Lake Superior.

This basin has a "lay" or position of its own, as a number of undulating sheets of sediment, dipping slightly to the southwest, here and there pierced by a peak of crystalline rock, and in certain regions raised into three broad low domes of great length.

11. The sedimentary rocks of this basin have submitted to two kinds of plutonic disturbance, independent of each other, and acting at distant intervals: 1st, that of secular or slow oscillation during deposition; 2nd, that of disturbance arising from paroxysmal uplifts long after their completion.

12. The whole Silurian and Devonian series of strata having, during deposition, sunk to the depth of 13,300 feet, it is submitted as a query whether it does not seem necessary to suppose that they were elevated

into their present position by the post-carboniferous uplift,—such agency being sufficient to produce all the observed phenomena, and the effects diminishing westwards from the central line of disturbance. No other agency is known to me, although hinted at by [some] American geologists.

13. It is a remarkable fact that brine-springs exist in considerable quantity in the middle stage of the Silurian system, a group or two below the Onondaga salt-springs of the upper stage, and three palæozoic systems below any salt deposits in Europe.

14. That the form and direction of the five great Canadian lakes are not due originally and mainly to the passage of loaded waters over their site, but that they follow the outcrops of their containing sedimentary rocks; changes in shape and size having, nevertheless, occurred since.

15. The contours of the valley of the St. Lawrence generally (to which much of New York belongs), and its increasing elevation southwestwards, inland from Montreal, are due to the successive altitudes assumed westward, in slopes and plateaux, by the Silurian and Devonian strata, the lowest or most ancient being on the east. This is beautifully evidenced in the rocks forming the basins of the great Canadian lakes.

16. That some of the groups, during and after deposition, were subatmospheric, presenting the conditions of dry land and shallow waters for long and varying periods,—and that, together with the marine life they supported, they enjoyed the influences of the sun and other meteorological agencies. This is indicated by animal tracks, sun-cracks on ancient shores, the short ripple-marks of a chopped sea, impressions of reeds waving in running water, and by the presence of bog-iron-ore. This is conformable with what took place in the carboniferous, permian, triassic, liassic, oolitic, wealden, and later periods. Denudations also occurred to most of the groups to a large extent.

17. That in New York, as elsewhere, there is an intimate connexion between fossils and their sediment or habitat. The calcareocolous animals are always found in limestone more or less pure, and the arenicolous in sandstone more or less pure,—with exceptions, such as usually happen with respect to locomotive animals. The calcareocolous are everywhere the most numerous. It is true that molluscs are the principal agents in the deposition of calcareous sea bottoms; but these latter greatly favor afterwards the multiplication of individuals.

18. That the iron-ore which we so frequently see investing invertebrate remains, had access to them after their death and sepulture.

19. Every group, as established by the State Geologists of New York, is a distinct centre of life,—a separate realm or community of animated beings, which may be called epochal, so marked are the differences.

The majority of these existences always perished at the end of the group when certain deposits ceased, because the new sediment, with its new and peculiar flora (and for other reasons,) was only able to nourish a few, if any, of the old molluscs.

20. In New York the species of fucoids occupy and are typical of only one group.

21. All the individual existences are perfect at once, from the earliest dawn of life, in their organization and social relations.

22. It is a great thought, that throughout the incalculably long succession of fossiliferous deposits, palæozoic or more modern, all animal and vegetable life was constructed upon the same idea of innervation, organs of sense, supply and waste, fecundation, &c.

23. There is another kind of life-centre—the geographic, belonging to one and the same group. This forms numerous separate provinces linked together by a few common fossils, and displaying extraordinary variety. This principle or regulation is carried out abundantly everywhere. Bohemia and Scandinavia have scarcely a Silurian fossil in common. One half of the Russian and Irish fossils, and two thirds of those of New York, are new and peculiar. Even the east and west sides of the small districts in Wales and England investigated by Prof. Philips, differ remarkably in their population. We see this in the American Tertiaries and in the recent seas.

24. Contrary to the opinion of Mr. D. Sharpe, the mollusc having the greatest vertical range has the greatest horizontal extension, being found in the most distant regions.

25. There is no evidence of multiplication of species by transmutation.

26. Fossils may be contemporaneous in geological age, without being contemporaneous *in time* as commonly understood.

Geological age is partly determined by fossil evidence. Now, the presence of living beings (subsequently fossil) depends on mineral and other conditions, such as temperature, depth, currents, &c., which were nowhere the same for large spaces, but were always undergoing changes from plutonic and other causes—changes always more or less local and limited, the deposits being thick or thin in places: so that the universal scheme of palæozoic life was not everywhere worked up to the same point; here preparations were making for Lower Silurian deposits,—there for the Upper, or Devonian, and so on. Thus isochronism was perhaps not common.

27. The principles of recurrency, succession, increment, and relative abundance of fossil species are the same in New York, Wales, and elsewhere, modified by local circumstances.

28. Recurrency, or reappearance in different strata, is at the same time the measure of viability in the species, and of connexion in the groups of strata. It is a kind of living nexus, pointing out that the groups belong to one and the same order of things. It may have been partly caused by migration.

Recurrency is not so common in New York as in Wales,—in other words, vertical range is longer in Wales. Great depth is an obstacle to the existence or transmission of living creatures.

29. Everywhere, on the eastern as well as on the western continent, the same fossils, of all orders and kinds, appear in the same succession. A very few Crustacea and a *Lingula* or *Obolus* or two, amid a dense matting of fucoids, appear at what now seems to be the dawn of life; then some Gasteropoda, a few Cephalopoda, and a few Brachiopoda in the third group from below (Chazy). But in the fifth group from below (Trenton,) multitudes of Zoophyta, Bryozoa, Brachiopoda (save *Spiriferi*,) Orthocerata, and Trilobites spring forth; but not a Lamellibranchiate. As species, they nearly all perish with the advent of a new deposit; but,

as genera, they appear one after another through the successive epochal centres, becoming multiplied in numbers and perfect in form. Then they lessen in numbers, dwindle in size, and finally disappear.

30. There is a close similarity in New York and Wales in the increment and decrement of Zoophyta, Bryozoa, Echinodermata, Brachiopoda, &c.; that is, these fossils are numerous and few at the same points of the Silurian scale.

31. The same genera, species, and amount of individuals abound or are few in the countries just named. Brachiopoda, Crustacea, Orthocerata, are many; Lamellibranchiates few. The extraordinary opulence in fossils of the Rhenish Devonian strata does not obtain in New York. In New York, however, according to our present list, the Lower Silurian stage is the most fossiliferous; in Wales, it is the Upper. Future discoveries may change this condition of things.

32. A remarkable feature in the uppermost four groups of New York Siluria (the Lower Helderberg) is the substitution in them of limestone for the arenaceous mud of the Welsh Ludlows, their contemporaries. It has given them a Wenlock character. But it is to be remembered that the Ludlow and Wenlock groups of Wales are in close fossil connexion, —74 out of 311 species of organic remains being common to both, or very nearly one quarter.

I shall not proceed at present with these inferences into the American Devonian system, although there is no want of interest. I may just remark that many Silurian Brachiopoda and some other molluscs work themselves up into the Devonian as representatives of a common period. They may even be found in the Carboniferous system, as has been proved by D'Archiac and De Verneuil to be not uncommonly the case in Europe.

The great ruling zoological principles of the Silurian system are continued into the Devonian; but in the latter we have the introduction of Vertebrates in profuse variety, and of new and complex types of Invertebrates in unwonted abundance, the old forms dying out.

6. *Report of the State House Artesian Well at Columbus, Ohio;* by W. W. Mather. 42 pp., 8vo., Columbus, 1859.—The Artesian well at Columbus had reached a depth of 1858 feet early in last December. For the first 23 feet the material passed through was sand, clay and gravel; then 15 of slate and 14 feet of Columbus limestone referred to the Devonian; 115½ feet Columbus limestone, probably Upper Silurian; below this 277 feet, the blue limestone of Cincinnati; then 187 feet (or to a depth of 764 feet,) limestone shales with salt water at 675 feet; then 823 feet of greenish marley slates, probably equivalent to the Utica slates of New York. Prof. Mather observes that "if the Cincinnati or Blue limestone be the equivalent of the Trenton limestone, Utica slates and Hudson river group, there must be a great depth of mud rock in Ohio, of which no traces exist in New York, Pennsylvania, or other States around us," and he inclines to regard the Blue limestone as Upper Silurian, but without settling the question by a sufficient appeal to facts.

7. *Synopsis des Echinides Fossiles;* par E. Desor. 1 vol. text, and 490 pp. 8vo, with 1 vol. of 44 8vo plates. Paris and Wiesbaden, 1858. —This work by Mr. Desor, now of Neufchatel, is devoted to the fossil Echinidæ, and contains descriptions of 1415 species of all geological ages, with a very large number of fine figures on the 44 crowded plates.

III. BOTANY AND ZOOLOGY.

British National Museums of Natural History.—The separation of Natural History collections at the British Museum from the library antiquities, seems to be inevitable at no distant period. An influen- memorial, addressed by leading naturalists to the Chancellor of the ıequer, strongly recommends this separation to be effected at the ɜnt time; and it is thought that the recommendation will be adopted. proposed to establish separate museums of zoology, botany, and ɔralogy, and even to divide each of these into a *typical* or *popular*, ɔonomic, and a *scientific* department, the two former open always to ɔublic, the latter to men of science. The zoological and perhaps the ɜralogical collections it is proposed to concentrate in some part of lon or the immediate vicinity, probably at Kensington Gore; the nical collection would of course go to Kew, where the national bo- ːal garden,—brought to a high state of perfection under Sir Wm. ker's superintendence,—and a large museum of economic botany, ; successfully established by him, already exist. There is likewise an llent herbarium, which was some years ago presented to the estab- ıent by Mr. Bentham. There also is the great herbarium of Sir . Hooker, perhaps the largest in the world,—certainly far larger than other ever formed in one life time, or by a private person, and the one ːh for the last twenty years has contributed more than any other to the ıncement of the science. For almost 20 years the Hookerian herbarium 'en more than the Royal Gardens—has made Kew the head-quarters otany, rivalling the imperial establishment on the other side of the ınel, and more useful as well as more freely accessible to botanists from y part of the world than the national herbaria at the British Museum. to accessibility, indeed, no fault is to be found with the latter; the ksian and other herbaria of historical importance could always be ulted under proper regulations. But it must be said that, with the test botanist of the age as their curator, these national collections for a 'ter of a century have not contributed to the advancement of botany ıy thing like the extent which the Hookerian herbarium, and its de- d, generous-spirited, and disinterested founder have done. How such st herbarium can have been collected and maintained, in perfect ɛing order, by a private individual of very moderate means, it is not to conceive. Certainly it is too large and too important for science to remain in private hands. It must in any case be acquired by the ish Government; when this and the Benthamian herbarium, with ɩuate provision for their increase,—supplemented by the Banksian and r special collections now at the British museum (which should be kept nct)—will form an unrivalled *scientific botanical museum*. A. G.

On the Coiling of Tendrils; by Prof. GRAY.—As much as twenty s ago, Mohl suggested that the coiling of tendrils 'resulted from an *ability* excited by contact.' In 1850 he remarked that this view has no particular approval to boast of, yet that nothing better has been in its place. And in another paragraph of his admirable little treat- n the Vegetable Cell (contributed to Wagner's *Cyclopædia of Phys-* *y*), he briefly says: 'In my opinion, a dull irritability exists in the

stems of twining plants and in tendrils.' In other words, he suggests that the phenomenon is of the same nature, and owns the same cause (whatever that may be) as the closing of the leaves of the Sensitive-plant at the touch, and a variety of similar movements observed in plants. The object of this note is to remark that the correctness of this view may be readily demonstrated.

For the tendrils in several common plants will coil up more or less promptly after being touched, or brought with a slight force into contact with a foreign body, and in some plants the movement of coiling is rapid enough to be directly seen by the eye; indeed, is considerably quicker than is needful for being visible. And, to complete the parallel, as the leaves of the Sensitive-plant, and the like, after closing by irritation, resume after a while their ordinary expanded position, so the tendrils, in two species of the *Cucurbitaceæ*, or Squash family, experimented upon, after coiling in consequence of a touch, will uncoil into a straight position in the course of an hour; then they will coil up at a second touch, often more quickly than before; and this may be repeated three or four times in the course of six or seven hours.

My cursory observations have been principally made upon the Bur-Cucumber (*Sicyos angulatus*). To see the movement well, full-grown and outstretched tendrils, which have not reached any support, should be selected, and a warm day; 77° Fahr. is high enough.

A tendril which was straight, except a slight hook at the tip, on being gently touched once or twice with a piece of wood on the upper side, coiled at the end into 2½–3 turns within a minute and a half. The motion began after an interval of several seconds, and fully half of the coiling was quick enough to be very distinctly seen. After a little more than an hour had elapsed, it was found to be straight again. The contact was repeated, timing the result by the second-hand of a watch. The coiling began within four seconds, and made one circle and a quarter in about four seconds. It had straightened again in an hour and five minutes (perhaps sooner, but it was then observed); and it coiled the third time on being touched rather firmly, but not so quickly as before, viz. 1¼ turns in half a minute. I have indications of the same movement in the tendrils of the grape-vine; but a favorable day has not occurred for the experiment since my attention was accidentally directed to the subject. I have reason to think that the movement is caused by a contraction of the cells on the concave side of the coil, but I have not had an opportunity for making a decisive experiment.—*Extr. from Proceedings of the American Academy of Arts and Sciences*, vol. iv, p. 98, *Aug.* 1858.

3. *An Essay on the Tape Worms of Man*, giving a full account of their Nature, Organization, and embryonic development, the pathological symptoms they produce, and the remedies which have proved successful in modern practice, by D. F. Weinland, Ph.D.,—to which is added an Appendix containing a catalogue of all species of Helminths hitherto found in man. 94 pp., 8vo, illustrated with original wood cuts. Cambridge, Mass., 1858. Metcalf & Co.—Dr. Weinland is high authority on all subjects connected with Intestinal worms, and especially the species that infest man, of which 32 are now known. This pamphlet is valuable both pathologically and zoologically. Nothing in the whole range of

animal life is more strange than the history of the tapeworm, and as the facts have not been in this Journal, we cite a few paragraphs on the subject.

"Every butcher is acquainted with the disease in the muscles of the domesticated hog, denominated 'measles,' and calls the flesh of such a hog 'measly pork.' It has long been known that those pea-like whitish globules (measles) contain a curious animal, namely, the perfect head and neck of a tapeworm, ending however, not in the long, jointed body of the regular tapeworm, but in a water-bladder. No traces of reproductive organs are to be seen. Such measles are found not only in the hog, but also in other animals, where they are better known under the name of *Hydatids.* For example, they are very often met with in the liver of rats and mice; in the mesentery of the hare; and even, though more rarely, in the muscles of man; and those of the latter have turned out to be of the same species (*Cysticercus Cellulosæ,* Rudolphi) as those found in the hog. All the different species of this sort of hydatids are known in science under the generic name of *Cysticercus.*

Again, other hydatids, varying from the size of a pea to a diameter of several inches, are occasionally found in the lungs, the liver, and other organs of man, but more frequently in the liver and lungs of our domesticated Ruminants, such as oxen, sheep, and goats. These hydatids are roundish bladders of a milky-white color, containing a watery fluid, in which swim many whitish granules; each of these granules is, as a good lens will show, a well-developed head and neck of a Tænia, inverted into a little bag. This kind of hydatid, also, has been considered as a distinct genus of intestinal worms, and called *Echinococcus.*

Again, a disease frequently occurs in the brain of sheep, producing vertigo (German, *Dreher*, French, *tournis*). This was ascertained, years ago, to be caused by another sort of hydatid, appearing as a bladder, often of several inches in diameter; and, as in Cysticercus and Echinococcus, filled with a watery fluid. On the outside of these bladders are attached a number (often hundreds) of tapeworm heads, all retractile into the inside of the bladder by inversion like the finger of a glove. This hydatid was considered by zoologists as a third genus, called *Cœnurus.*

These three genera, *Cysticercus*, *Echinococcus*, and *Cœnurus*, formed until recently an order in the class of intestinal worms, called *Cystica* (Bladder worms, or Vesicular Worms). But *we now know that all of this group are merely larves of tapeworms*, and that the whole order of *Cystica*, being composed of larves of *Cestoidea*, must therefore be dropped from our zoological system.

This important discovery was made as follows. Ephraim Götze, a German clergyman and naturalist of the last century, had noticed a singular similarity between the heads of some Cysticerci and those of some tapeworms. He had particularly noticed this similarity between the tapeworm of the cat (*Tænia crassicollis,*) and the Cysticercus which is found in the liver of the rat and mouse (*Cysticercus fasciolaris*). C. T. von Siebold, the most noted helminthologist now living, had observed the same thing, and in 1848 had already alluded to the possibility that all these Cystica might be nothing but undeveloped or larval tapeworms. In his system, however, he still recognized the *Cystica* as a distinct order of Helminths.

In the year 1851, F. Küchenmeister first proved by experiment that a certain hydatid when brought into a suitable place, is developed into a tapeworm. He fed a dog with the hydatids (*Cysticercus pisiformis*) found in the mesentery of the hare, and on dissecting the dog, after a number of weeks, *found these Cysticerci alive in the small intestine. They had, however, lost their tail-bladder, and the neck had begun to form the joints of a true tapeworm*, which worm had been long well known as *Tænia serrata*, and as common in the dog. Now, one discovery followed another. Governments, scientific institutions, and wealthy farmers furnished the money and animals to carry on the experiments on a large scale. Siebold fed a dog with the *Echinococcus* of the ox, and thus raised the *Tænia Echinococcus*, Siebold. It was also found in the same way that the *Cœnurus* from the brain of sheep is the larve of another *Tænia* of the dog, *Tænia Cœnurus*, Siebold.

Now the question, whence does man get his tapeworm? was ready to be answered. It had been observed that the hydatids of the hog, commonly called "measles" (in the zoological system, *Cysticercus Cellulosæ*,) have exactly the same head as the common tapeworm of man (*Tænia Solium*, L.); and after the experiments mentioned above, in relation to the different tapeworms of dogs, a doubt could hardly exist *that Cysticercus Cellulosæ of the hog was the larve of the common human tapeworm* (*Tænia Solium*). Küchenmeister, who wished to make sure of the fact, made the experiment upon a criminal who was soon to be executed, and, as was to be expected, with perfect success. Measles taken from fresh pork, and put into sausages which the criminal ate raw, at certain intervals before his death, were found again, in the post-mortem examination, as tapeworms in his intestine, and in different stages of development, according to the intervals in which the measles had been taken.

Thus it became clear, that all hydatids are tapeworm larves, which, when swallowed with the animal, or a portion of it, in which they live, by another animal, develop in the intestine of the latter. * * * *

Now the opportunity for experiments was again open in another direction. If the tapeworm embryo developed its scolex or head by interior budding, it was likely that those animals having hydatids got them by eating the eggs of the species of tapeworm to which those hydatids belonged. And this has been proved by experiment. Goats fed with eggs of the *Tænia Echinococcus* got the Echinococcus; sheep fed with the eggs of *Tænia Cœnurus*, got the Cœnurus in their brain; *healthy young hogs fed with the eggs of the human tapeworm got the measles.* Küchenmeister, Siebold, Van Beneden, Gurlt, Luschka, Wagener, Leuckart, Eschricht, and others, have the merit of tracing this interesting development. From their further investigation, it became moreover evident, that the Cœnurus also, with its many heads, originated from *one* embryo, which, enlarging greatly, throws out as buds from its interior, not one, but many scolices; moreover, that the process is also exactly the same in *Echinococcus*, except that in this hydatid the scolices free themselves after a while from the internal walls of the bladder, and thus swim in the fluid contained in the bladder, the latter itself being simply the enlarged embryo.

But the zeal of these investigators did not rest here. If the sheep gets by chance the eggs of the *Tænia Cœnurus* of the dog into its stom-

ach, how do the embryos hatching from those eggs reach a suitable place for their development into hydatids, which place is, in the sheep, the brain? It had been erroneously assumed that they bored with their spines *recta via* from the stomach through all the tissues and organs until they reached the brain. Accordingly, in the hog, the embryos of the Tænia would have to go from the stomach into the muscles; in the rat, into the liver; and in the ox, into the lungs; for it is only in these particular organs that these hydatids are found.

R. Leuckart, however, discovered the way in which the embryos actually reach their destined resting places. On feeding rabbits with the eggs of *Tænia serrata*, he found that, some hours after the feeding, the egg-shells were already dissolved into prismatic granules by the juices of the *stomach*, and the embryos set free. But on putting the eggs immediately in the *intestine* (through an artifical opening,) they were not hatched. It was clear, therefore, that only the gastric juice could hatch the embryos; and this accounts at once for the strange fact, that the embryo never hatches in the intestine of the animal where the tapeworm itself lives. Moreover, he found that they do not pass from the stomach into the intestine, and hence, as had been supposed, through the bile-ducts into the liver, but that they pierce the blood-vessels, and *thus come into the circulation.* He even, after a long search, found four perfect embryos in the blood taken from the *vena portæ. It is by the blood that the embryos of tapeworms are carried to the organs in which they develop iuto hydatids.* It now at once became obvious how easily they reach the muscles, the brain, the lungs, etc. But it is to be supposed that only those which reach the destined organ will develop themseves, while the rest, which are carried to other organs, must perish."

The subject is continued with a full description of the common tapeworm and of other species. The extreme length is stated by Diesing at twenty-four feet.

4. *Depth of Molluscs of Peconic and Gardiner's Bays, Long Island, N. Y.;* by Sanderson Smith. (Communicated for this Journal.)

Name.	Depth.	Remarks.
Loligo illecebrosa,		Large and abundant.
Banella caudata,	— to 10 f.	Moderately abundant.
Pyrula canaliculata,		Abundant.
Pyrula carica,	L. W. to 10 f.	"
*Buccinum plicosum,	H. W. to 10 f.	Large and abundant.
*Nassa obsoleta,	Littoral.	Very abundant.
*Nassa trivittata,	2 f. to 10 f.	Abundant.
*Columbella avara,	L. W. to 10 f.	Moderately abundant.
*Columbella Gouldiana,		Rare.
Columbella lunata,	L. W. to 10 f.	Mod. abundant.
Pleurotoma cerinum,*		Rare.
Pleurotoma plicatum,	2 f.	Not so rare as preceding.
*Natica heros,	10 f.	Rare and small.
*Natica duplicata,	10 f.	" " "
*Natica triseriata,	2 f. to 10 f.	Mod. abundant.
Natica pusilla,*		One dead specimen.

Names.	Depth.	Remarks.
*Natica immaculata,		One dead specimen.
Eulima subangulata,*		Rare.
Chemnitzia producta,*		"
*Chemnitzia fusca,		"
*Chemnitzia seminuda,	2 f.	Only once found, numerous.
Chemnitzia trifida,	Low water.	Moderately abundant.
Chemnitzia bisuturalis,	Low water.	Rare.
*Chemnitzia interrupta,	4 or 5 f.	"
Scalaria clathrus,*		One dead specimen.
Scalaria lineata,*		" " "
Cerithium Sayi,	L. w. to 2 f.	Extremely abundant.
Cerithium nigrocinctum,*	L. w. to 10 f.	Rare.
Cerithium Greenii,	L. w. to 2 f.	"
Cerithiopsis Emersonii,*	4 f. to 10 f.	Moderately abundant.
Cerithiopsis terebellum,*	4 f. to 10 f.	" "
Cæcum pulchellum ?*	In sand at 10 f.	Abundant.
Vermetus radicula,*		The tip of one specimen.
*Littorina rudis,	Littoral.	Very abundant.
*Littorina littoralis (animal white),	Littoral.	Abundant.
Littorina " (animal black),	Littoral.	"
*Lacuna vincta,	Low water.	Moderately abundant.
" " var. fusca,	" "	" "
*Rissoa minuta,	Low water.	Extremely abundant.
Skenea ? n. s.*		One dead specimen.
*Calyptrea striata,		" " "
*Crepidula fornicata,	H. w. to 10 f.	Very abundant.
*Crepidula convexa,	L. w. to 10 f.	Abundant.
*Crepidula unguiformis,	L. w. to 10 f.	"
*Tectura testudinalis,	Low water.	Moderately abundant.
Chiton apiculatus,	4 f. to 10 f.	" "
*Melampus corneus,	Littoral.	Very abundant.
Actæon punctostriatus,		Rare.
*Bulla solitaria,		"
*Bulla canaliculata,	2 f.	Not so rare as preceding.
Æolis, n. s. ?	Low water.	One specimen.
Ostrea borealis,		Rare.
*Anomia ephippium,	H. w. to 10 f.	Very abundant and large.
" vars. electrica and squamula.		
Anomia aculeata,		Rare.
*Pecten irradians,	L. w. to 3 or 4 f.	Extremely abundant.
*Mytilus edulis,	Littoral.	Not very abundant.
*Mytilus modiolus,	— to 10 f.	Abundant.
*Mytilus plicatulus,	Littoral.	"
Arca transversa,	3 f. to 10 f.	"
Arca pexata,		Rare.
Nucula proxima,	2 f. to 10 f.	Abundant.
Leda limatula,	2 f. to 3 f.	Rare.
Leda sapotilla,	3 f.	"
*Solemya velum,	4 f. to 10 f.	"

Names.	Depth.	Remarks.
Solemya borealis,		A fragment.
Cardium Mortoni,	L. w. to 1 f.	Abundant and large.
*Cardium pinnulatum?		One valve.
Astarte mactracea,*		Dead specimens abundant.
*Venus mercenaria,		Moderately abundant.
*Cytherea convexa,		One valve.
*Venus gemma,	— to 2 f.	Very abundant.
Petricola dactylus,		Rare.
*Petricola pholadiformis,		"
*Mactra lateralis,	2 f. to 6 f.	"
*Mactra solidissima,	10 f.	Rare and small.
*Kellia planulata,		"
Montacuta elevata,		One valve.
*Tellina agilis (St.),	2 f. to 6 f.	Moderately abundant.
Tellina tenta,*	— to 6 f.	" "
*Tellina fusca,	— to 6 f.	" "
Cumingia tellinoides,*		" "
*Solen ensis,		Not very abundant.
Solecurtus bidens,*		Rare.
*Mya arenaria,	Littoral.	Very abundant.
Corbula contracta,		Abundant.
*Anatina papyracea,	3 f.	Two specimens.
*Cochlodesma leanum,	3 f.	Rare.
*Lyonsia hyalina,	— to 6 f.	Moderately abundant.
Thracia Conradi,		A few odd valves.
*Pandora trilineata,	3 f. to 6 f.	Rare.
*Saxicava distorta,		"

Turdo, Theca, Ascidia, a Cynthia, a Molgula, two or three Aplysiæ, and six or seven Botrylli and Polyclina.

Recapitulation.—One Cephalopod, forty-three Prosibranchs, one Pulmonifer, three Tectibranchs, one Nudibranch, forty-one Lamellibranchs, and fifteen Tunicates, altogether one hundred and five marine species. Besides these, *Astarte castanea, *Cyprina islandica,* *Mesodesma arctatum, *Purpura lapillus, and *Buccinum undatum, occur on the Sound and about Montauk Point, making a total of one hundred and ten species for the eastern end of Long Island. Twenty-nine of these (marked with a * after them) excluding the Tunicata, are additional to those stated by Dekay to occur in the waters of the State, though many of them are surmised by him to exist there. I have no access to a library, to determine how many have since been described as coming from them. Including the Tunicata, the number would rise to forty-three or forty-four. Sixty-two species (marked with a * before them), or sixty-five per cent, (excluding the Tunicata,) pass Cape Cod. Only twenty-nine other species are stated by Mr. Stimpson, in his "Shells of New England," to pass the Cape, so that 68·1 per cent of the whole number occur here; and a little dredging about Montauk would probably discover nearly all the others.

IV. ASTRONOMY.

1. *Fifty-fourth and fifty-fifth Asteroids.*—The asteroid discovered Sept. 10, 1858, by M. Goldschmidt at Paris, has been named *Alexandra*, and is numbered as the *fifty-fourth* of the series. The asteroid discovered on the same night, by Mr. George Searle at Albany, N. Y., has been named *Pandora*, and is numbered the *fifty-fifth.*

2. *Another Asteroid.*—In 1857, Mr. E. Schubert of Washington, undertook a series of observations of the asteroid *Daphne.* On computing his observations he was surprised to discover that he had not found Daphne but had observed for it a new asteroid in the neighborhood. He has computed its elements, and it is to be hoped that the body will be redetected.

3. *Review of Gilliss's Astronomical Observations in Chili,** (from Gould's Astronomical Journal, 1858, p. 168).—This volume, though bearing the date of the year in which the observations were printed, has only been issued a few weeks. It contains 332 pages of observations of *Mars* and *Venus* during two oppositions of the former and inferior conjunctions of the latter, made at Santiago by Lieut. Gilliss or under his superintendence. These series comprise both micrometric comparisons with the equatorial, and absolute determinations with the meridian circle. These are followed by 69 pages from the Washington Observatory, containing a description of the equatorial and a series of micrometric observations by Mr. Ferguson of each of the four oppositions or conjunctions. A portion contributed by Mr. Bond of the Cambridge Observatory contains 43 pages of observations of *Mars* during the opposition of 1849–50, chiefly micrometric determinations of right-ascension. Finally, Mr. Maclear, of the Royal Observatory at the Cape of Good Hope, has furnished an extensive series of micrometer-comparisons with the preselected stars, during the first opposition of *Mars.*

These 492 pages of observations and accompanying remarks are preceded by introductory remarks upon the origin and operations of the expedition, with a description of the instruments and method of observation employed, by Lieut. Gilliss; and by a detailed discussion of the entire mass of observations by the editor of this Journal. This discussion occupies 264 pages.

The plan of the expedition contemplated micrometric comparisons of the limbs of the planets, with stars previously selected by Lieut. Gilliss for the purpose, simultaneously made in the northern and southern hemispheres; but the extremely small number of northern observations precluded all hope of attaining any valuable addition to our knowledge of the Solar Parallax by this method.

In the earnest desire that so extended and costly a series of careful observations should not prove futile for the attainment of the desired end, a method of discussion has been employed, which, though entailing an inordinate amount of toil, seemed to afford the only adequate means of rendering the observations serviceable for the fulfilment of their design. The method may be briefly described.

* The U. S. Astronomical Expedition to the Southern Hemisphere, during the years 1849–52. Vol. III: Observations to determine the Solar Parallax, by Lieut. J. M. Gilliss, LL.D., Superintendent. Washington, 1856. 4to.

A catalogue of the comparison-stars having been prepared, their declinations were obtained from a thorough examination of all the available sources, and from the combination by weights of the positions as given by the several authorities. Regard being had to the existence of any possible proper motion, the positions obtained were referred to the mean equinox of the beginning of the year in which the comparisons were made, and a final list of comparison-stars thus constructed, containing not only the declinations of each star, but the relative value of the determination.

The complete reduction of all the observations was then repeated, and the several comparisons with each star consolidated with care into a single observation, of which the weight was determined, and which was subsequently treated like an absolute determination of place, and even combined with meridian observations. Each of the four series (viz. the two *Mars*-oppositions and the *Venus*-conjunctions) was treated independently, and the error of the ephemeris considered as of the form $x+\tau y+\tau^2 z$, τ denoting the time from a medial epoch. Four other unknown quantities were introduced,—two of these relating to the apparent semidiameter, one depending on the micrometer employed, and the last being the correction to Encke's determination of the mean solar parallax. The observations at each place have been independently discussed, and the several groups finally combined in series of approximate solutions by least squares.

The sequel indicates that the results afforded by the series of observations of *Mars*, during the opposition of 1849–50, so far surpass any of the others in precision and trustworthiness, that these, taken alone, promise a closer approach to the desired values than when combined with the three other series.

The resultant determinations of the whole discussion are as follows:

Semidiameter of *Mars*	$= 4''\cdot6639 + 1''\cdot9681 = 6''\cdot63$
" " *Venus*	$= 8\cdot6625 - 0\cdot3118 = 8\cdot35$
Mean Solar Parallax	$= 8\cdot5712 - 0\cdot0762 = 8\cdot4950$

The great increase of the previously assumed semidiameter of *Mars* is very striking. It has proved impracticable in most cases to free the semidiameter from the possible influence of an irradiation dependent on the observer or on the telescope. The adopted value depends on the Washington and Santiago observations only. The necessity of some increase to the previously adopted value is indicated by six series of observations; being all made, during the first opposition, with the exception of the Cape of Good Hope series.

The propriety of a small diminution of the adopted diameter of *Venus* seems also to be distinctly and strongly pointed out.

Upon the resultant value of the parallax I am not inclined to place any great stress, but cannot refrain from expressing the decided conviction that the value obtained by Encke from the transits of *Venus* in 1761 and 1769 may be improved by a slight decrease; and am inclined to regard the value $8''\cdot5000$ as being in all probability quite near the truth, and that this value may be advantageously adopted. G.

V. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *Mountains of North Carolina and Tennessee;* by S. B. BUCKLEY. (Communicated for this Journal).—During the summer of 1835, Professor Elisha Mitchell of Chapel Hill University, North Carolina, measured the highest point of the Black Mountain in that State, and announced its height to be 6476 feet. His stationary barometer was at Morganton, which he *estimated* to be 968 feet above the sea. The late railroad surveys show that the Morganton depot is 1169 feet high; making the place where Dr. Mitchell's stationary barometer hung, 1200 feet above the level of the sea. Hence the height of Mount Mitchell—the name which has justly been given to the highest part of the Black Mountain—according to the indications given by Prof. Mitchell's barometer in 1835, is 6708 feet. This measurement of 1835 was first published in the Raleigh Register, and again in Silliman's Journal in 1839, with some additional remarks by Dr. M., in which he alludes to the great apparent height of the mountains in Haywood county, and also to the highest in the Great Smoky Range. The Highland Messenger, published at Asheville, near the Black Mountain, in 1840 when alluding to Dr. M.'s measurement of it, says: "we are perfectly willing to concede the name of Mount Mitchell to that particular point of the Black Mountain which Prof. Mitchell, after a degree of labor and expense, which none other than a genuine devotee of science would have incurred, demonstrated to be the most elevated point of *measured* land east of the Rocky Mountains. We say measured land, because we have long believed, and still believe that there is one, if not two points, in the same range of mountains higher than that measured by Prof. Mitchell, from forty to sixty miles west of the Black Mountains." This is from an editorial by the Rev. D. R. McKally, D.D., now editor of the Christian Advocate at St. Louis, Missouri. We have quoted it, because his *higher points* are probably the two highest which we have recently measured in the Smoky Range, about sixty miles nearly west of the Black Mountains.

In the Transactions of the Smithsonian Institution for 1855, is Mr. Clingman's account of the Black Mountain, the highest point of which he estimates to be 6941 feet, which is 233 feet higher than Prof. Mitchell's corrected height of the same point. Prof. Turner the engineer has since found its height to be 6711 feet, and in 1856 Prof. Guyot by a series of barometrical observations, ascertained it to be 6701 feet high. There is little discrepancy between the measurements of Professors Mitchell, Turner and Guyot, and hence there can be little doubt that Mr. Clingman's estimated height of the Black Mountain, as first given in the Smithsonian Transactions, and now in Colton's new atlas of the World, and also in Lippincott's Gazetteer, is at least 230 feet above its true height.

Prof. Mitchell in 1838 and 1844 again visited the Carolina mountains, at which time his stationary barometer was at Asheville. The following measurements, then made, are taken from a letter of his, published in an Asheville newspaper.

	Above the sea.
"Asheville,	2200 feet.
French Broad river at Asheville,	1977 "
Lower Ford of Pigeon,	2475 "
Waynesville,	2722 "
Head of Scott's Creek,	3240 "
Tuckaseige Ford,	1927 "
Gully Whee Gap,	3897 "
Blue Ridge head of Tuckaseige,	3795 "
Col. Zachary's Cashiers valley,	3324 "
Chimney Top,	4433 feet.
" " above Zachary's,	1109 "
Burnsville,	2763 "
Top of Black Mountain,	6772 "
Morganton,	1081 "
Table Rock,	3584 "
Grandfather,	5719 "
Roane,	6187 ""

It should be remembered that these measurements were also made previous to the railroad surveys, by which it is now known that the height of Asheville near the court house is 2260 feet.

For the convenience of future observers we give below, Prof. Guyot's measurements in 1856, in and around the Black Mountains, the three last excepted.

	Above the sea.
Jesse Steppa, Lower Mountain house, Swaninoa valley,	2770 feet.
Terminus of carriage road up Black Mt. to Wm. Patton's Mt. House,	3244 "
Potatoe Top,	6389 "
Mitchell's Peak,	6577 "
Mount Gibbes,	6586 "
" Haulback,	6401 "
Sandoz Peak,	6612 "
Cattail Peak,	6595 "
Rocky Trail Peak,	6486 "
Deer Mountain,	6216 "
Long Ridge Middle Peak,	6253 "
Bowlen's Pyramid at north end of the Black,	6345 feet.
Wm. Patten's Mt. House,	5248 "
Mt. Mitchell, "highest,"	6701 "
Guyot's Peak,	6661 "
Hairy Bear,	6597 "
Junction of Cattail Fork and Caney river,	2824 "
Burnsville court house square, near Penland's Hotel,	2819 "
Mount Pisgah,	5760 "
Roane Mt.,	6318 "
Grandfather, measured in 1858,	5897 "

Prof. Guyot remarks in a letter to us containing his measurements in 1856, that "these heights may be modified by a few feet in" his "final publication, the point of base not being identified within three feet."

The following are the heights of some mountains and places in North Carolina and Tennessee, south and west of Asheville, which were measured by us with two of Green's standard barometers during the months of September and October in 1858. Prof. J. LeConte of Columbia, S. C., observed the stationary barometer at Waynesville, N. C., for the measurement of most of the highest Smoky Mountains, but being called away by the duties of his professorship, the stationary barometer was removed to Col. Cathey's, at the Forks of Pigeon, Haywood Co., N. C., and placed in charge of Miss S. Cathey. We also received material assistance from Mr. T. J. Lenoir and Mr. Turner Cathey, during our mountain excursions.

	Above the sea.
Waynesville,	2815 feet.
Col. Cathey's,	2750 "
Platt's Peak,	6196 "
Jones' "	6337 "
Amos Platt's Balsam,	6406 "
Cold Mountain,	6105 "
Shining Rock,	6063 "
Father Old-Field,	6116 "
Hyman's Peak,	6095 "
Cathey's "	6240 "
Wilson's Balsam,	6270 "
Mount Hargrove,	6156 "
Devil's Court House,	6057 "
Lenoir's Bald Mt.,	6040 feet.
Mount Hardy,	6257 "
Mount Lenoir,	6413 "
N. Peak of Mt. Lenoir,	6399 "
Sarah's Mountain,	5993 "
Mount Cathey,	5742 "
" Starling,	6456 "
" Emmons,	6465 "
Flat Creek Balsam,	6087 "
Whiteside,	5076 "
Top of Whiteside to base of precipice,	1510 "
Mount McDowell,	5100 "

The following points are in the Smoky Mountains, and many of them are on the State line, between North Carolina and Tennessee.

E. P. Hopkins's house,	1995 feet.	White Rock Mountain,	5002 feet.

This last is a misnomer of the hunters, being composed of a dark gneiss and mica slate, covered in many places with white lichens, the most abundant of which are Cladonia rangiferina, and Cladonia Caroliniana.

Mount Safford,	6296 feet.	Old Field Knob,	6220 feet.
" Henry,	6425 "	Peck's Peak,	6338 "
" Guyot,	6734 "	Safford's Peak,	6559 "
" Floyd,	6073 "	Mount LeConte,	6670 "
" Mingus,	5779 "	Mount Buckley,	6755 "
Summit of Road Gap near the Alum Cave,	5814 "	Curtis' Peak,	6511 "
Right Hand Gap,	5162 "	Mount Collins,	6241 "
Mount Ocona,	5978 "	Robert Collins House,	2535 "

It is proper to state that most of these heights are the result of a single barometrical observation, and hence they will probably be modified somewhat by future observers. Observations were made on the two highest at two different visits, and a mean result between the two calculations is given as the height of Mount Buckley, while the height of Mount Guyot is given as ascertained by the first visit, it being made in a more settled state of the weather. The second observation at its summit gave its height as 6994 feet. It is well known to those conversant with the barometrical measurement of heights, that accuracy requires a series of observations, and it was out of our power to make them at so many points during the time to which we were limited by the lateness of the season.

Fortunately the months of September and October were uncommonly dry, which enabled us to continue exploring nearly the entire time. The toil was great, and the difficulties to be encountered can only be imagined by those who have ascended the steeps of the unfrequented Southern Alleghanies, through laurel thickets (Rhododendrons and Kalmia,) and multitudes of the prickly locust, (Robinia hispida,) which has a *penchant* for scratching the face and hands, tearing the clothes, and occasionally the skin beneath. We found the Viburnum lantanoides or hobble-bush with its straggling branches, very troublesome on the Smoky Mountains. Notwithstanding all this we have the mountains and their glorious scenery. We encamped eleven nights on their tops; and saw that the stars were brighter, and the planets apparently larger than when seen from the valleys below. Then also the wonderful comet (Donati's) made the southwest luminous with its bright head and mysterious tail, soon after the setting sun.

The scenery of these mountains, especially those in the Smoky Range, abounds in precipices and deep chasms, surpassing any thing we remember to have seen among the White Mountains of New Hampshire. The spectator on the highest Smoky Peaks can enjoy a more varied view than from any other points in the Southern Alleghanies. East Tennessee with its towns, rivers, and the Cumberland mountains in the distance, is spread beneath at the west. On the north can be seen the Clinch mountains extending into Kentucky. At the northeast, east, and southeast, in full

view are all the higher mountains of North Carolina, and at the south the smaller ones of Northern Georgia. Such prospects *pay* the explorer for his toil; their remembrance is always sweet. The country on the Tennessee side is much lower than in South Carolina, and the descent of the Smoky mountains is generally more abrupt and precipitous into the former State, than into the latter.

The highest Smoky mountains are near the head waters of the Ocona-luftu and Little Pigeon rivers, being accessible from Tennessee via Sevierville, and up the Little Pigeon to a Mr. Hawkins', who lives eight miles from the top of the gap road, which is near the alum cave; and from North Carolina by the road up the Ocona-luftu to Mr. Collins's house, seven miles from the top of the afore-named gap-road.

The geology of the mountains south and west of Asheville has a good deal of sameness, they being composed of crystalline rocks, with the exception of a narrow strip, extending southwest along the Unaka or Smoky mountains which belongs to the taconic system of Emmons. The taconic rocks here consist of dark colored shales in which we do not remember to have seen any organic remains. The strata of these rocks are in many places nearly and often quite vertical. They are well exposed along the Middle or Straight Fork of the Ravensfork in descending from Mount Guyot to the Ocona-luftu. They also occur at the summit of the gap-road near Mount Mingus, and extend two or three miles down the road into North Carolina. The chief rocks of the Haywood mountains are granite, gneiss and mica slate, excepting a small portion near the Smoky Range, where the taconic rocks are again found. The Shining-Rock mountain about eleven miles south of the Forks of the Pigeon is entirely of white or milky quartz, and is probably the largest mass of that rock at any one point in the Alleghanies. It has a fine appearance in the distance and is deservedly becoming quite a place of resort. We believe that Haywood and Jackson counties, N. C., have not as yet afforded any paying mines to those who have been at the expense of working them, but it must be admitted that they have been little explored for that purpose. Prof. Emmons the State Geologist, contemplates a survey of those mountains next summer, and we suspect that he will destroy the golden dreams of a few who build castles upon undeveloped mineral wealth.

This region has long been a favorite place of resort for the botanist. Here there is a strange mixture of northern and southern species of plants, while there are quite a number which have been found in no other section of the world. In the months of May and June when the Kalmia, Rhododendrons and Azaleas are in bloom, these mountains and valleys present an array of floral beauty which is indigenous to no other section of the United States. The much vaunted western prairies with their interminable sameness, are by no means as beautiful. The Rhododendron Catawbiense, Kalmia latifolia and Azalea calendulacea, are not excelled by any native floral beauties; the two last abound in nearly every section of these mountains, but the first rarely descends into the valleys. Besides these the Rhododendron maximum, (laurel,) Rhododendron punctatum, Azalea arborescens and nudiflora, Oxydendrum arboreum, Chionanthus Virginica, Halesia tetraptera, Clethra acuminata, Robinia hispida and

viscosa, Stuartia pentagyna, Liriodendron tulipifera, Magnolia acuminata, Umbrella, and Fraseri, grow there more or less abundantly, and they are all ranked as among the most ornamental trees and shrubs of the Atlantic States. The Pyrus Coronasia is very common south of the French Broad river; Catalpa occurs in several places along the same river and in the mountain valleys near the Warm Springs; Cladastris, grows at Paint Rock, Tenn., which is near the Warm Springs. Most of the highest mountain tops are covered with the Abies nigra and Abies Fraseri: the former is the black spruce, and is erroneously called the balsam; the latter is the true balsam with blisters in its bark, from which balsam is collected. It attains a greater size than Pursh or Nuttall have given it in their works. We measured some on Wilson's Balsam and near Cathey's Peak, which were more than three feet in diameter and from eighty to one hundred feet high. The black spruce appears to grow at a lower elevation than the balsam, but neither of them are often met beneath an height of 4000 feet.

The banks of streams and coves of these mountains have some of the largest trees in the United States east of Mississippi river. There is a Tulip tree or Poplar (Liriodendron tulipifera,) near the Pigeon river in Haywood Co., N. C., about eight miles from the Tennessee line, thirty-three (33) feet in circumference at three feet from the ground, or eleven feet in diameter, and upwards of one hundred feet high. Another on the western slope of the Smoky mountains in Tennessee, on the Little Pigeon river, is twenty-nine feet in circumference at three feet from the ground. Near this locality we also measured a chestnut (Castanea vesca,) thirty-three feet in circumference at four feet from the ground. It is a noble living specimen, apparently sound, and of nearly a uniform diameter upwards, for forty or fifty feet. About two miles farther up the same stream there is a hemlock, or spruce pine, (Abies Canadensis) nineteen feet and two inches in circumference at four feet from its base. Here also the Halesia tetraptera attains an uncommon size, being from two to three feet in diameter, and about sixty feet high. On Jonathan's Creek there is a white oak (Quercus alba,) nineteen feet in circumference at three feet from the ground. This list of large trees could greatly be extended, but enough have already been cited to show the richness of those coves and valleys.

The Quercus Leana of Nuttall occurs at several places on the Tennessee river near Franklin in Macon Co., North Carolina. It is evidently there a hybrid between Quercus imbricaria and Q. tinctoria. Its acorns are identical with those of the Q. imbricaria. On the Haywood mountains we saw a few specimens of the Betula excelsa (yellow birch), and Mr. Curtis says he found it on the Black mountain. Among several shrubs which we obtained for cultivation the Pyrularia oleifera or oil-nut is peculiarly interesting. It grows to the height of from five to ten feet, and bears a pear-shaped fruit little more than an inch in diameter, which is so oily that it will burn like a candle if a wick be drawn through it. Squirrels are fond of it, and cattle have a great liking for the young branches and leaves of the Pyrularia. Last spring we saw an abundance of it in the edge of some woods fenced into a wheat field, and in October we again went there after the fruit; but the harvest was past, the

field had been pastured with cattle, which had destroyed nearly all of the Pyrularia. Hence it has already become rare, and the general occupancy of the mountains with herds of cattle and flocks of sheep would soon destroy it entirely. Mr. Durand of Philadelphia thinks that the oil expressed from it is superior to the best olive oil. Our specimens of the Pyrularia have been planted at Philadelphia, New York, and at the botanic garden of Cambridge, near Boston, and also some of them have been sent to Paris to the Acclimating Society of France, whose object is to acclimate useful trees, shrubs and plants.

On Mount Mingus we first met with the Rugelia, a new genus of Shuttleworth, in the natural order Compositæ, which has not yet been described in American works on botany. It is frequently found along the Smoky mountains to the extent of twenty-five or thirty miles. Dr. Gray recognized it at once, he having received it from Mr. Shuttleworth, a European botanist to whom Rugel sent plants. Sixteen years before, in the early spring, we had visited those same mountains with Dr. Rugel, a German botanist, and we were right glad to learn that his name was affixed to one of their interesting plants. The Solidago glomerata grows on most of the Balsam mountains, and the Potentilla tridentata of the New England mountains also grows on the bald peaks of Macon county, North Carolina.

The Carolina mountains have a great variety of huckleberries (Vaccinium and Gaylussacia) ripening in succession from July to September. When we first met with acres of those bushes, in September, covered with large delicious fruit, the temptation was so great that we partook rather freely, expecting to pay the penalty of over indulgence, but were happily disappointed. Judging from the experience of others and our own on many occasions, those berries are remarkably healthy. Most of them were larger than any we ever saw at the south. The Vaccinium Constablei of Gray, which sometimes grows ten or fifteen feet high (on Shining Rock), was covered with ripe fruit as late as the middle of October. There are several species of the huckleberry which are worthy of cultivation. The common high blackberry (Rubus villosus) is often found in dense patches on and near the mountain tops, with its stems smooth, and destitute of prickles. This rule is constant. We do not remember to have met with an exception. The same species growing in the valleys has its stems armed with prickles.

In the month of September many of the women and children dig "sang," (Aralia quinquefolia,) in the valleys and on the mountain sides. The dry roots of the ginseng or "sang," as it is always there called, are worth at home twenty-five cents per pound. We met with one man who had bought 30,000 pounds, and we remember being with one family whose children sold seventy pounds of dried sang. These roots are dug with a long narrow hoe called the "sang hoe."

Snow birds (Fringilla nivalis) we saw on the Black mountain, and also on many of the other Balsam mountains south and west of Asheville. They were solitary or in pairs, showing evidently that they breed in those places. Another species of bird, whose summer habitat is generally supposed to be confined to the north, also breeds and summers in those Balsam mountains. It is the Crossbill (Loxia curvirostris) whose curious

bill is well adapted to extract seeds from the cones of the black spruce and balsam trees. In the mountain valleys we frequently met with many northern birds, among which was that sweet songster, the rose-breasted Grosbeak (Fringilla Ludoviciana).

The tedium of the night, when encamping on the mountains, is almost always enlivened by the stories of the guides and their adventures in hunting. They all positively assert that the bears in early spring, when first emerging from their winter quarters, are as fat as when they first retire for the winter. During the winter they shed the soles of their feet, which renders their walking difficult in the first of spring, when their food consists of the young plants, on which diet they soon become lean, and remain so until the ripening of berries in August and September. They are very fond of hogs and pigs, pork and honey being their favorite diet. Why they bite and scratch the bark and limbs of the balsam and black spruce we cannot tell. It cannot be for food, because they do not generally leave the marks of their teeth on a tree, except in one or two places. Sometime they rise on their hind legs and make long deep scratches in the bark with their fore paws. It may be done for sport, or to let their companions know their whereabouts. We have seen those fresh bites and scratches on different trees at all seasons of the year. The bears show great sagacity in feeding at the leeward of the paths on the mountain ridges, along which the hunter is almost obliged to travel, hence if the wind blows it is almost impossible to get a shot at them, their keen scent discovering the hunter long before he gets within shooting distance. They are stupid and unwary about traps, entering without fear the log pens; these are shallow, with a depth of not more than two feet, over which is raised a very heavy top, which falls and crushes the bear when he disturbs the bait. Hundreds are caught in this manner every year. In the unfrequented parts of the mountains the large steel trap is concealed in the bear trail; but this is dangerous, and liable to catch dogs, of which we saw two caught in one morning to our great sorrow. The piteous yells of those unfortunate dogs rang in our ears long afterwards. The bears rarely disturb calves or young cattle, but in one locality of the Smoky mountains we were told that they did much damage in killing young cattle, and that there could be no mistake about it, because a large bear had been caught in the act of killing a young steer. The panther, wild cat, and wolf are all troublesome to the mountain farmer of those regions. The panther destroys sheep and hogs; the wild cat, lambs and pigs. Both are cowardly and thievish, being rarely seen.

The Red squirrel (Sciurus Hudsonius) called Mountain Buman in North Carolina, is common on all the higher mountains. They rarely descend into the valleys. They are fond of the seeds of the balsam and black spruce, and as they are rarely molested by the hunters, they are very noisy, active, and more fearless of man than their brothers at the north. The Ground squirrels (Sciurus striatus) are also very abundant, often destroying a good deal of corn, but as corn is plenty, and larger game common, the ground squirrel is rarely killed. We were told by a travelling fur merchant, whom we there met, that the skins which he bought among the mountains, equal in fineness and goodness those of

; north, and that northern merchants could not tell the difference; ll in order to get the highest price he was obliged to send his skins to w York, through Ohio and *via* the Erie Railroad as if they had come m the northwest. The principal furs obtained in the southern Alleanies are the skins of the otter, mink, black fox, red fox, raccoon, and iskrat.

From the great height of the southern Alleghanies, there being twentyir peaks higher than Mount Washington, it will be readily inferred at they have a northern climate. A year ago, our guide to the top of ane told us that he had been on its summit when it was covered with ow on the 17th of June. There is a table land extending from near the ane to the head of Turkey Cove and Linville Falls, a distance of twenty thirty-five miles, on which the inhabitants succeed with difficulty in ising Indian corn sufficient for their own consumption. Occasionally ay have frost during every month in the year, and then they resort on rseback or on foot to the valleys for corn. About the first of last May saw the mountains in Haywood covered with snow about six inches ep. The wheat harvest at the Forks of Pigeon begins about the first ek in July; and we know of no better criterion for isothermal lines an the time of ripening wheat. We kept a record of it in western w York, and in ten years the annual time of beginning the wheat rvest did not vary three days from the 16th of July.

The valleys in the Carolina Mountains vary in elevation from two ousand to upwards of three thousand feet, hence a few miles travel will en take one to a much warmer or colder climate. This we experienced ry sensibly in going from the valley of Jonathan's Creek to that of the co River. The former has a mean elevation of about three thousand t and the latter near two thousand. The Chinese sugar-cane (Sorghum) extensively grown, and may be regarded as a decided success. There e few portions of the Union where such a production is more needed. e absence of railroads and the cost of transportation render sugar and olasses dear; hence the introduction of the Chinese sugar-cane in that ction is a great blessing, and will enable many a poor family to have eet coffee.

In no section of the United States have we seen finer apples, and they e mostly from seedlings originally planted by the Indians. Silas cDowell of Franklin, in Macon Co., has devoted more than twenty years the selection and grafting of those best native apples, and he now has orchard of more than 600 apple trees, which bear fruit equal if not perior to the best northern kinds. There is said to be a line or belt the mountain sides about three hundred feet above the adjoining plain valley, and extending upwards several hundred feet, where fruit trees ways bear, because the belt is free from frost. If this be true,—and believe its truth has been pretty well tested by experiment,—the untains of North Carolina might supply the South with an abundance the choicest fruit, if the means of transportation were good. By the ltivation of more grass, and the introduction of the improved breeds cattle into those mountain valleys, butter and cheese might also be de for the southern market. One great drawback to the raising of ep is that they are destroyed by wild animals, and also killed by the

dogs. Still we think it would even pay well to keep sheep, herd them at night, and have a shepherd with his dog to guard them by day, and thus revive old Arcadian times among those delightful mountains.

2. *On some Modified Results attending the Decomposition of Bituminous Coals by Heat;* by Dr. A. A. Hayes.—When bituminous coal is exposed in proper vessels to a gradually increasing temperature, at a certain point decomposition commences and continues, while heavy hydrocarbon vapors, mixed with the vapors of water and salts of ammonia, escape, and may be condensed.

The proportion of permanent gases formed is small in comparison with the weight of the liquids produced, when the decomposition of the coal is carefully regulated.

In the ordinary rapid breaking up of the composition of coal by heat suddenly applied in the manufacture of illuminating gas, the proportion of permanent gases is increased, but the heavy fluid hydrocarbons are also formed. This mode of decomposition is evidently a mixed one, partaking of the characters of a regulated distillation, while at the same moment a more complete destruction of the coal is proceeding in some parts of the mass.

A further decomposition of the fluid products, condensed from either or both of these modes of operating, takes place when we again subject them to the influence of heat; and this well-known fact is the basis on which improvements in the manufacture of illuminating gas have been founded,—a secondary destruction of vapors being effected in appropriate apparatus, heated to a high temperature.

This character, which all the bituminous coals exhibit, of passing into carbon nearly free from vapors only when heavy fluid hydrocarbons are also formed, has, in a chemical view, been the strongest fact adduced in opposition to the generally received opinion that the anthracites and semi-anthracites have resulted from chemical changes of bituminous coal, through the agency of the heat of igneons rocks which have disturbed their beds. The heavy hydrocarbons, represented by ordinary coal tar, are the most indestructible bodies known; and wherever anthracites exist, we should expect to find near by those products of the chemical changes effected in the coal. Such is the delicacy of the balance existing between the elements of the heavy hydrocarbons, that no second distillation of them can be effected; they always undergo decomposition by heat, with the separation of carbon, which under any known natural conditions, would remain to attest their previous presence.

Considerations of this kind have led me to experiment on the changes which coals undergo by heat, where the influencing conditions were not the same as those usually seen; and the results of extended trials demonstrate that the bituminous coals may be broken up into permanent gases, vapors of water, and ammoniacal salts, while carbon remains as a fixed product.

If we substitute, for the ordinary forms of apparatus used in decomposing coal by heat suddenly applied, any modification of form which compels the gas, as it forms, to escape from the more highly heated part of the mass of coal, through a small opening, or, better, a small eduction pipe, the heavy hydrocarbons do not form part of the products which

escape. Generally the light, nearly colorless, oils of the benzole series, appear with the aqueous solutions of the ammoniacal salts, while only an accidental quantity of carbon is deposited in the eduction-pipe. The carbon left is more than usually compact and hard; and such coals as ordinarily produce much water, when they form heavy hydrocarbons, afford less than half the usual amount, when thus decomposed, under the influence of the constant presence of an atmosphere of permanent gases.

In following the observations at the earlier stage, it was found that the size of the eduction-tube leading the gas from the hotter part of the mass of coal undergoing changes, exerted a most marked effect on the composition of the products. It was established as a fact, that in an ordinary coal-gas retort, the size of the conduit might be varied so as to allow the tar-like bodies to form, or to prevent their appearance at pleasure.

But a more remarkable result was obtained, when, after having prevented the production of heavy hydrocarbon fluids, the influence of reduced size of tube was studied in its relation to the composition of the gas afforded by a particular kind of coal. To a certain extent, the chemical constitution of the gas formed was found to be under control, and the conclusion reached was, that dissimilar permanent gases may be thus obtained from the same parcel of coal without a modification of temperature.

Any explanation of the change of composition induced in the volatile parts of bituminous coals under the above-described conditions should not include mechanical pressure, which is no greater than often exists in ordinary cases.

It seems probable that the presence of an atmosphere of nearly permanent gases in the decomposing vessel, and the regular continuous flow of them from the coal, prevent the formation of heavy vapors at the instant of change in the coal. In support of this point, we find the temperature necessary to convert coal into gas without the presence of heavy hydrocarbons much less high than when they are produced.

We may therefore observe the decomposition of coal without the simultaneous formation of tar, and *beds of coal may be converted under existing natural conditions to anthracite, without secondary products being formed.*

3. *Museum of Comparative Zoology in Harvard University.*—Since the connection of Professor Agassiz with the scientific department of Harvard University, he has been actively devoted, as is well known, to collecting zoological specimens and laying the foundation of a great museum. The collections already made by him or through his agency, and in great part at his own expense, are very large. The interest felt in this movement has been general through the country, and has recently taken a fresh start which is destined to lead to the most important results. The late Francis C. Gray of Boston—a gentleman extensively known for the depth and variety of his knowledge in many departments of literature, and for his liberal spirit in promoting schemes for the public good—was strongly attached to the study of the natural sciences, during the last years of his life, and was in habits of intimate and cordial association with Prof. Agassiz.

This distinguished gentleman died two years ago. He left by will his large, choice, and most valuable collection of engravings to Harvard College, together with a fund of sixteen thousand dollars to defray the expense of cataloguing and preserving them. But the most important of his legacies for public objects is that of fifty thousand dollars, as described in the extract from his will, quoted by William Gray, his nephew and executor, in a letter addressed to the corporation, dated Boston, Dec. 20, 1858, as follows:

"And also give, out of such surplus only, to Harvard College, or such other institution as you see fit, the further sum of fifty thousand dollars; the income to be applied to establishing and maintaining a Museum of Comparative Zoology; not to be appended to any other department, but to be under the charge of an independent Faculty, responsible only to the Corporation and Overseers. No part of said income is to be expended for real estate or the payment of salaries."

The conditions under which this donation has been bestowed on Harvard University are as follows:

"*First*, That the same be kept as a separate and distinct fund, and invested from time to time at the discretion of the Corporation, provided that no part thereof shall ever be invested in real estate, or in the shares or stock of any incorporated or joint-stock company.

"*Second*, No part of the income of said fund shall ever be expended for real estate or the payment of salaries.

"*Third*, The income is not to be subject to any charges of any nature, but the whole amount derived from the fund is to be applied to establishing and maintaining a Museum of Comparative Zoology at Harvard College.

"*Fourth*, Neither the collections, nor any building which may contain the same, shall ever be designated by any other name than the Museum of Comparative Zoology at Harvard College.

"*Fifth*, The Museum shall never be appended to any other department, but is to be under the charge of an independent Faculty, responsible only to the Corporation and Overseers.

"*Sixth*, The President of the College shall be the President of the Faculty, which shall be composed of four members besides the President. In case of vacancies in their number, other than that of President, the Faculty shall from time to time nominate to the Corporation persons to fill such vacancies; and if confirmed by the Corporation, such persons are to become members of the Faculty; if rejected, new nominations shall be made by the Faculty to the Corporation.

"*Seventh*, The Faculty are not to be at liberty to expend any part of the income of the fund, unless previously placed at their disposal by the Corporation.

"*Eighth*, The first Faculty shall consist of Rev. Dr. James Walker, President of the College, Professor Louis Agassiz, Director of the Museum, Dr. Jacob Bigelow, Professor Oliver Wendell Holmes, and Professor Jeffries Wyman.

"*Ninth*, In case of the loss of any part of the fund, so much of the income as may be requisite for this purpose shall be retained to make good such loss, provided that not more than one-half of the income shall be so retained in any one year.

"*Tenth*, That the Corporation enter this donation, with its conditions, upon their records, and vote to accept the same."

The conditions above prescribed are most judicious. The object for which the fund is established, in their nature cannot change. But there still remained other objects which imperatively demanded to be provided for. The collections of Professor Agassiz are at present in a small wooden building, which the torch of an incendiary might in an hour reduce to ashes, and thus annihilate the fruit of twelve years toil. Attention has been repeatedly called to this subject, and the announcement that Mr. William Gray, in the exercise of the discretion vested in him by his uncle's will, had decided to give the fifty thousand dollars for the support of the Museum, with the limitations already recited, seemed to be a sufficient reason for bringing the necessity of a fire-proof building again before the public. The matter was forcibly presented by Prof. Agassiz to the Visiting Committee of the Scientific School, in January. We give an extract from this document, which has been printed by order of the Overseers.

"I have laid out a plan which I will simply submit to you. I am afraid you will consider it extravagant, but if I understand rightly the aspirations of the young men with whom I am every day brought into contact, I cannot consider it over-sanguine, or doubt that the time is coming before long, when the scientific progress of the country will demand such an institution.

"My hope is that there shall arise upon the grounds of Harvard a Iuseum of Natural History, which shall compete with the British Iuseum and with the Jardin des Plantes. Do not say it cannot be done, r you cannot suppose that what exists in England and France cannot reached in America. I hope even that we shall found a museum hich will be based upon a more suitable foundation and better qualified advance the highest interests of science than these institutions of the world.

'But although I have sketched a plan for such a museum, I am never-ess fully aware that, at the beginning, it must be carried out in a mer commensurate with the probable means that may be secured. us first erect a wing of that ideal museum, at an expense of perhaps 000, or, if that is too much, let us limit ourselves to such rooms as give fitting shelter to the collections already on hand, and secure from the danger of fire and other casualties. A spark of fire in slight wooden building, where the collections are now heaped ier, would be sufficient to destroy in half an hour the collections it has cost me twelve years to amass, and which I can truly say is ost valuable collection for the student of natural history on this ent, and, in some of its classes, superior to any in the world. The ossibility of unpacking what is already in our possession under f, crowded together in barrels and boxes, inaccessible to myself or lents, of displaying them to the public, and making them useful y, will, I have not the slightest doubt, be a sufficient stimulus in munity to secure what will be needed to finish the structure and r it worthy of the institution with which it will be connected, nlightened people who understand that in our age, culture is the

only true distinction among nations. One thing only should not be overlooked, that whenever any structure is put up for the museum, it should not be built in a corner where it cannot grow, but be placed on such grounds as will never be an impediment to its indefinite increase.

"In its present condition the museum hardly furnishes me the specimens I require for my courses of instruction, for, in consequence of the daily accessions which are heaped upon those already crowded in this narrow space, it is often impossible to find what is wanted at the time, and it is out of the question to allow free access to the Museum in its present confused state, to any student not already trained in the manipulation of specimens. Had I six or eight rooms of the size of the two now at my disposition, I could at least make a fair beginning of a systematic arrangement, separate the duplicates from what is to constitute the collection proper, allow free access to the rooms for the public as well as the students, and thus create a more general interest for this establishment, while the students themselves would derive all the advantages which such a collection ought to afford them in their studies. At the same time, the separation of the duplicates from the collection proper would furnish ample materials for an extensive system of exchanges with other institutions of the same kind, by which the collection would at once be at least doubled in all its parts, and in some of its departments increased three or four times, and in some, even tenfold. The advantages of such a system of exchanges are very obvious, and my inability from want of room to separate the duplicates from the collection, has already been, for some years past, a check upon its increase. I hope, therefore, that as soon as it is fully understood, some remedy for this evil may be found.

"But even the possession of an appropriate building will not altogether put an end to our difficulties. The collection is already so large that it is impossible for me to take charge of it alone, even were I to give all my time to its care. For many years past I have already been under the necessity of having one or two, and at times even three assistants, who, at my private expense, have been, most of the time, engaged in taking care of the specimens. As I have nothing in the world but what I earn daily, such an expenditure has frequently been for me a source of unendurable anxiety, of which I wish to free myself, that I may hereafter devote whatever energy I may possess untrammeled to the higher interests of science. In this perplexity I have thought that a number of curatorships, (corresponding to the scholarships now existing in the university, which enable young men, whose private means are insufficient for such an object, to receive a college education) might perhaps be founded by some of our wealthy citizens, which would furnish a small income to students who have already taken their degree, and who, wishing to prosecute further their studies under my direction, might thus earn the means of remaining in Cambridge by assisting in the arrangement and preservation of the collection, as well as in making the exchanges. The position of the curators in the scientific school would thus be similar to that of the tutors in the undergraduate department. In a well organized museum there should be as many curators as there are branches in zoology, including embryology, paleontology and zoological anthropology. In the

course of time, the curatorships (to which should be attached the duty of delivering a certain number of lectures annually) may be endowed so as to afford the means of appointing special professors for each branch, and as soon as this is accomplished, our organization would be more perfect than that of either the British Museum or the Jardin des Plantes. Beside the curators, there should be one or two preparators, to mount specimens, and to make the necessary preparations required for the illustration of the specimens. It would also be desirable to have an artist attached to the establishment, who would have to make magnified drawings of such specimens as are too small to be at once studied by the natural powers of the eye; these drawings would be appropriate ornaments for the corridors, and at the same time assist in the courses of lectures which it should be the duty of every curator to deliver annually upon the special branches intrusted to his care."

The very able chairman of the committee, the Hon. John H. Clifford, made an earnest report, urging upon the Overseers and the community the importance of acting at once upon the suggestions of Prof. Agassiz. The interest which these communications immediately excited, was great and general, and steps were taken to carry out, or at least to commence the execution of the plan. Several meetings of the most distinguished and enlightened citizens of Boston have been held, and liberal sums have already been promised. A general subscription has been undertaken, with the certainty of success. Not only this, but the subject has already been brought before the Legislature, and there is strong ground to believe that a handsome appropriation will be made, from the moneys received by the State from the sale of the "Back Bay" lands. Governor Banks, in his annual message, called attention, in general but emphatic terms, to the value of the natural sciences, and has since shown a liberal disposition to favor this particular measure. The Hon. Charles Hale, Speaker of the House of Representatives—and one of the most rising young men in Massachusetts—is also understood to be a warm friend of the proposal. Other leading persons in the government look upon it with favor, and there seems little doubt that a majority of the Legislature will take the same enlightened view. F.

4. *Observations on the Genus Unio*, together with descriptions of new species, their soft parts, and embryonic forms, in the family Unionidæ. 96 pages 4to, with 29 plates; by ISAAC LEA, LL.D. (From the Journal of the Academy Nat. Sci. Philad., 1858).—These researches constitute a volume, of which the first paper was read in Dec. 1857, and the remaining two in November, 1858. The embryonic form of the shell in the case of 38 species of Unionidæ is figured without details on one of the plates. The prevalent form is pouch-shaped, the height much greater than the length. In the last paper on new Unionidæ of the United States, numerous species are described and well figured. Dr. Lea observes that he has found the *Unio cylindricus* Say, *U. rubiginosus* Lea, and *Anodonta imbecilis* Say, sensitive to light, as if possessing some kind of visual organs, and that Prof. Haldeman had observed and published the same for the *Unio radiatus*. Mr. Lea's first publication on this point was in the Proceedings Acad. Nat. Sci. Philadelphia for February, 1857.

5. *On the Stratification of Vesicular Ice by Pressure;* by Prof. WILLIAM THOMSON, F.R.S., in a letter to Prof. STOKES, Sec. R.S., (Proc. Roy. Soc. from Phil. Mag., Dec. 1858.)—In my last letter to you I pointed out that my brother's theory of the effect of pressure in lowering the freezing point of water, affords a perfect explanation of various remarkable phenomena involving the internal melting of ice, described by Prof. Tyndall in the number of the "Proceedings" which has just been published. I wish now to show that the stratification of vesicular ice by pressure observed on a large scale in glaciers, and the lamination of clear ice described by Dr. Tyndall as produced in hand specimens by a Brahmah's press, are also demonstrable as conclusions from the same theory.

Conceive a continuous mass of ice, with vesicles containing either air or water distributed through it; and let this mass be pressed together by opposing forces on two opposite sides of it. The vesicles will gradually become arranged in strata perpendicular to the lines of pressure, *because of the melting of ice in the localities of greatest pressure and the regulation of the water in the localities of least pressure, in the neighborhood of groups of these cavities.* For, any two vesicles nearly in the direction of the condensation will afford to the ice between them a relief from pressure, and will occasion an aggravated pressure in the ice round each of them in the places farthest out from the line joining their centres; while the pressure in the ice on the far sides of the two vesicles will be somewhat diminished from what it would be were their cavities filled up with the solid, although not nearly as much diminished as it is in the ice between the two. Hence, as demonstrated by my brother's theory and my own experiment, the melting temperature of the ice round each vesicle will be highest on its side nearest to the other vesicle, and lowest in the localities on the whole farthest from the line joining the centres. Therefore, ice will melt from these last-mentioned localities, and, if each vesicle have water in it, the partition between the two will thicken by freezing on each side of it. Any two vesicles, on the other hand, which are nearly in a line perpendicular to the direction of pressure will agree in leaving an aggravated pressure to be borne by the solid between them, and will each direct away some of the pressure from the portions of the solid next itself on the two sides farthest from the plane through the centres, perpendicular to the line of pressure. This will give rise to an increase of pressure on the whole in the solid all round the two cavities, and nearly in the plane perpendicular to the pressure, although nowhere else so much as in the part between them. Hence these two vesicles will gradually extend towards one another by the melting of the intervening ice, and each will become flattened in towards the plane through the centres perpendicular to the direction of pressure, by the freezing of water on the parts of the bounding surface farthest from this plane. It may be similarly shown that two vesicles in a line oblique to that of condensation will give rise to such variations of pressure in the solid in their neighborhood, as to make them, by melting and freezing, to extend, each obliquely *towards* the other and *from* the parts of its boundary most remote from a plane midway between them, perpendicular to the direction of pressure.

The general tendency clearly is for the vesicles to become flattened and arranged in layers, in planes perpendicular to the direction of the pressure from without.

It is clear that the same general tendency must be experienced even when there are bubbles of air in the vesicles, although no doubt the resultant effect would be to some extent influenced by the running down of water to the lowest part of each cavity.

I believe it will be found that these principles afford a satisfactory physical explanation of the origin of that beautiful veined structure which Prof. Forbes has shown to be an essential organic property of glaciers. Thus the first effect of pressure not equal in all directions, on a mass of snow, ought to be, according to the theory, to convert it into a stratified mass of layers of alternately clear and vesicular ice, perpendicular to the direction of maximum pressure. In his remarks "On the Conversion of the Névé into ice,"* Prof. Forbes says, "*that the conversion into ice is simultaneous*" (and in a particular case referred to "*identical*") "*with the formation of the blue bands;* .... and that these bands are formed where the pressure is most intense, and where the differential motion of the parts is a maximum, that is, near the walls of a glacier." He further states, that, after long doubt, he feels satisfied that the conversion of snow into ice is due to the effects of pressure on the loose and porous structure of the former; and he formally abandons the notion that the blue veins are due to the freezing of infiltrated water, or to any other cause than the kneading action of pressure. All the observations he describes seems to be in most complete accordance with the theory indicated above. Thus, in the thirteenth letter, he says, "the blue veins are formed where the pressure is most intense and the differential motion of the parts a maximum."

Now the theory not only requires pressure, but requires difference of pressure in different directions to explain the stratification of the vesicles. Difference of pressure in different directions produces the "differential motion" referred to by Professor Forbes. Further, the difference of pressure in different directions must be continued until a very considerable amount of this differential motion, or distortion, has taken place, to produce any sensible degree of stratification in the vesicles. The absolute amount of distortion experienced by any portion of the viscous mass is therefore an index of the persistence of the differential pressure, by the continued action of which the blue veins are induced. Hence also we see why blue veins are not formed in any mass, ever so deep, of snow *resting* in a hollow or corner. * * *

6. *Thoughts on Matter and Force, or marvels that encompass us, comprising suggestions illustrative of the theory of the earth and the universe;* by Thomas Ewbank, author of "Hydraulics and Mechanics," &c. 154 pp. 18mo. New York, 1858.—There are many excellent thoughts in this little work. But we cannot subscribe to its main doctrines, that expansion is the only effective moving power in a forming earth; that the earth's heat is due to pressure from gravitation; and that gravitation is a means of preventing any decrease of the mean temperature of a globe

* Thirteenth Letter on Glaciers, section (2), dated Dec. 1846.

because heat is generated by pressure and by friction attending the circulation of the hot liquid. Expansion and contraction for a given change of temperature are equal in amount and also in mechanical power, and both may be sources of movements in the earth's crust. As regards the circulating liquid, the power causing the circulation is equivalent in amount of heat expended to the heat produced by the friction in the circulation, so that there can be no increase from this source. Since gravitation can produce no condensation except there be a loss of heat, it cannot be a means of augmenting the heat; and hence, whatever may be the amount at any moment, the sphere will still lose by radiation, and find its only possible means of compensation for the loss in external sources. The author touches on geological topics while no geologist, and therefore without being aware of the points that are to be met in the required explanations.

7. *Shower of Mud at Corfu.*—Dr. G. Lawson describes a mud shower as having occurred at Corfu on the 21st of March, 1857. The day was squally and showery, and with the rain came down a light shower of mud which covered lightly the leaves of the trees and garden plants. Under microscopic examination the earthy material was found to consist mainly of quartz grains and not of minute organisms.

8. *Notes on American Land Shells, No.* 4; by W. G. Binney, (Proc. Acad. Nat. Sci. Philad., 1858, Nov.)—Mr. Binney in this paper gives a catalogue of American Terrestrial Mollusks, with full lists of synonyms, which will be found of great convenience to all interested in this subject.

9. *Memoirs of the Geological Society of Great Britain, and of the Museum of Practical Geology.* The Iron Ores of Great Britain. Part II, The Iron Ores of South Staffordshire; by J. Beale Jukes, with various analyses, made under the direction of Dr. Percy. 64 pp. 8vo. London, 1858.—The South Staffordshire iron works occur in an area of 60 square leagues about Dudley.

10. *Smithsonian Report for* 1857.—The Smithsonian Institution is doing for science what is done by a Royal Society abroad; and much more. For besides publishing elaborate papers and works which would fail of a publisher on account of the expense, it is giving activity to science over the land,—calling out zealous research, and full collections of observations and specimens, in explorations over the Rocky Mountains and the regions west,—making a gallery of Indian portraits, the Stanley collection being deposited there, with the prospect of its being purchased by government,—gathering a cabinet of the natural productions of the United States,—collecting a library of all the Transactions of foreign Societies and Journals, which is already remarkably complete and nearly as possible up to the date of publication,—eliciting and issuing Reports on different departments of science,—sustaining a series of lectures at Washington through the winter,—and making itself, for the great convenience of the country, a medium of communication in the way of publications, between the science of the two Continents. This Report gives a brief account of the publications and encouragements of researches and general progress of the Institution the past year; also lectures by Prof. Joseph LeConte and Prof. S. Alexander, communications on Meteorology, and a Translation of Dr. J. Müller's very valuable Report of recent progress in Physics, made by G. C. Schæffer.

It contains also the decision of the Board of Regents upon the charges brought by Prof. S. F. B. Morse (contained in Shaffner's Telegraph Companion in 1855) against Prof. Henry, implying his "consciously and willfully deviating from the truth and this too from unworthy and dishonorable motives" in his testimony respecting the claims of Mr. Morse touching the origin of the electro-magnetic telegraph. The charges were of so gross a character, that Professor Henry, under a sense of the responsibilities of his position as Secretary, deemed it incumbent on him to bring them before the Board. The report of the Committee of investigation pronounces the charges unsustained. Prof. Henry follows the report with a history of the discoveries that prepared the way for the telegraph.

11. *Straw Lightning rods.*—The power of straw as a conductor of electricity has been utilized in the south of France, no less than eighteen Communes in the neighborhood of Tarbes having been provided with conductors composed of straw. Experiments show that an electrical shock sufficiently powerful to kill an ox may be discharged by a single straw.—*Athen., No.* 1630.

12. *Tschudi.*—Dr. Tschudi, the well-known traveller, has just returned from his last journey to Peru; the results of which will be submitted shortly to the public.—*Ib.*

Obituary.—*Death of William C. Bond.*—We are pained to announce the death of William Cranch Bond, Esq., the director of the Astronomical Observatory of Harvard College. He died at Cambridge, Mass., Jan. 29, 1859, aged 69. He was born in Portland, Me., Sept. 9, 1789. Before his appointment to the Cambridge Observatory, he had devoted himself with much industry, talent and success, not only to astronomical observations, but to the construction and improvement of optical instruments, in every detail of which he was well informed and practically skillful. Having gained a reputation as an observer at his private observatory in Dorchester, he was called to the charge of that in Cambridge, in 1839, before any buildings were erected. The great telescope was mounted June 24, 1847. In connection with his sons, he has used that great refractor with important results, in observations of the fixed stars, the nebulæ, and the planet Saturn. To his practical skill observers owe a piece of mechanism, called the "Spring Governor," by which time is visibly measured to a small fraction of a second. To the same skill in applying scientific knowledge to mechanical means was in a large part owing what is known in Europe as the "American method" of recording astronomical observations by electro-magnetism. He has been engaged with encouraging success in experiments for taking photographs of the stars by a camera attached to the great telescope. Before his appointment at Cambridge he was employed by the U. S. Government in making astronomical observations in connection with those of the South Sea Exploring Expedition. Mr. Bond's talents and acquirements as a skillful astronomer were duly appreciated not only in this country but also in Europe. In 1842 the honorary degree of Master of Arts was conferred on him by Harvard College. He was a member of the American Academy of Arts and Sciences, of the American Philosophical Society, and of the Royal Astronomical Society of London. By his death the College is deprived of a highly valued officer, and the scientific community of one of its most gifted and accomplished sons.—*Boston Daily Advertiser.*

Synopsis of the Report on Zoophytes; by James D. Dana. 8vo. New Haven, 1859; containing descriptions of all the spe Author's original 4to. Report, which is out of print.

H. L. Bowditch: Address on the Life and Character of James Dea Greenfield, Mass. 46 pp. 8vo.

Lieut. J. C. Ives: Colorado Exploring Expedition, Preliminary Rep tain A. A. Humphreys, Topograph. Engineers. 12 pp. 8vo.

J. Cassin: Mammalogy and Ornithology of the United States Exp dition under Captain Wilkes, U. S. N., 1838-1842. 1 vol. 4to in 466 p folio atlas of 53 colored plates, 11 of mammals and 42 of birds.

F. T. Conington: Handbook of Chemical Analysis. London: Long The author adopts the notation of the Laurent school.

Sir R. I. Murchison: Geological Map of England and Wales, 16 in London: E. Stanford. 5s.—7s. mounted in case.

Andrew C. Ramsay: Geological Map of England and Wales, 36 in. 12 miles to the inch. London: E. Stanford. 25s. in case, 30s. on roller

Knipe: Geological Map of Scotland including the Shetland and Ork London: E. Stanford. 25s. mounted in case.

G. R. Greenough: General Sketch of the Physical and Geological British India. Size 80 in. by 68, scale 25 miles to 1 inch. London: 4l. 4s. on a roller and varnished or folded in a case.

Lake Price: A manual of photographic manipulation; treating of of the art in its various applications to nature, with 50 engravings on don. 6s. 6d. J. Churchill.

J. Russell Hind: An Astronomical Vocabulary. London. 1s. 6d. ker & Son.

G. W. Lowry: Atlas of Physical and Historical Geography. Engrave direction of Prof. Ansted and Rev. C. G. Nicolay. London. 5s. J. W. P

John Matthew Jones, Esq., assisted by Major J. W. Wedderburn and dis, Esq.: The Naturalist in Bermuda; a sketch of the geology, zoolo any of that remarkable group of islands, together with meteorological o London: Reeves and Turner.

H. P. Prescott: Tobacco and its Adulterations. London: Van Voor giving the means of distinguishing the kinds of leaves mixed with tob croscopic and botanical evidence.

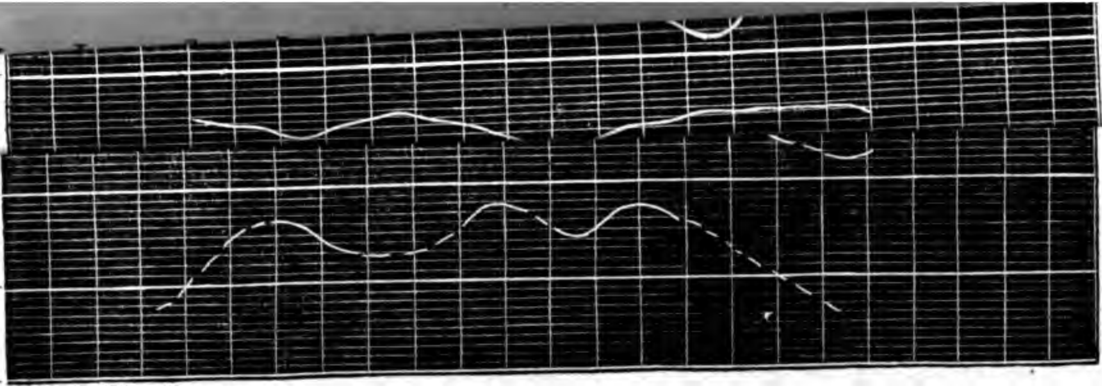
Milne-Edwards, H.: Leçons sur la physiologie et l'anatomie comparée et des animaux. T. IV. 1re parte. In-8. *Victor Masson.* 6*fr.*

Leuckart, Rdf.: Zur Kenntniss des Generationswechsels und der Part bei den Insekten. Mit 1 lith. Taf. *Frankfurt a. M.*, 1858. Meidinger 8°, IV, 112 pp.

F. Ritter von Hauer and Fr. Foetterle: Geologische Uebersicht de der Osterreichischen Monarchie, mit einer vorwort von Wilhelm Hai pp. 8vo. Vienna, 1855.

Proceedings Acad. Nat. Sci. Philadelphia, 1858, Nov. and Dec.— cies of Cristatella from near Newport, R. I.; *J. Leidy.*—p. 190, Note on *insculpta* of Hall; *Christy.*—p. 191, Birds of Hakodadi, collected by Dr. derson, U. S. N.; *J. Cassin.*—p. 197, Notes on American Land Shells, *G. Binney* (see p. 300).—Plate 3 of the new Lepidopter, *Argynnis* an well colored.—p. 213, Hadrosaurus Foulkii, Reptile from the Cretace Jersey; *J. Leidy, W. P. Foulke, I. Lea.*—p. 223, Ichthyological Notes; —Prodromus, &c. (Crustacea of the North Pacific Expedition) Anon *Stimpson.*—p. 253, New Genera and species of N. American Lizards in of the Smithsonian Institution; *S. F. Baird.*—p. 256, Remarks on the taceous beds of Kansas and Nebraska together with descriptions of som cies of Carboniferous fossils from the valley of Kansas river; *Meek* and

Annals of the Lyceum of Natural History of New York, Vol. VI, —p. 303, Synopsis of the Genus Achatinella; *W. Newcomb.*—p. 336, certain species of North American Helicidæ (continued); *T. Bland.*—p. sis of the Fresh Water Fishes of the Western portion of the Island W. I.; *T. Gill.*

3d. A. M.	A. M. 8 26		South 2 to 4; cloudy.
A. M.	0 35		4—7 P. M. calm.
			Northeast gale Oct. 31 P. M. to afternoon of Nov. 2d. Conjunction, Nov. 5th.
Nov. 2d. P. M.	A. M. 9 24		At Oconto River the water fell 12 inches with the wind still northeast.

NOTE.—Thermometer read at 5 A. M.—Lowest water of the season, Oct. 16, 2 P. M., being 24½ inches, B, wind S. 3.—Highest, Nov. 2d, 2 P. M., 15 inches, A, wind N. E., a gale.—Difference 39½ inches.—April 17, 1848, 23 inches, A.

THE

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[SECOND SERIES.]

ART. XXXII.—*On the Fluctuations of the Water Level at Green Bay, Wisconsin;* by CHAS. WHITTLESEY, of Cleveland, Ohio.

THE town of Green Bay is situated at the mouth of the Fox (or Neenah) river. As far up the river as "Des Peres," or about five miles, the water is dead and deep enough for navigation by sail vessels. The first rapid is at Des Peres, the seat of the earliest French mission on the Fox river, taking its name from the Jesuit fathers, of whom relics yet remain. Here a dam and lock have been built as part of the improvement of the river.

Movements of the waters at the mouth and along the still water portion of the channel are so frequent and so marked as to attract the attention of travellers and residents from the days of the Jesuits to our own. The current is seen flowing rapidly up stream as far as the rapids almost every day, and sometimes more than once or twice. With the influx is a rise sometimes very small, at others reaching one and even *two* feet, as the following tables show.

Notwithstanding the curiosity excited by this series of movements, very few measurements have been made. The early numbers of this Journal contain, I believe, all the observations heretofore made, but I have not the advantage of referring to them. Those which I now present are by no means complete, but may be of some value in discussing the question of lunar influence.

In the month of August, 1858, at my request, D. Underwood, Esq., cheerfully consented to make hourly observations so far as it could be done consistently with his occupations. Mr. Underwood is the observer at Green Bay for the Smithsonian Institution at Washington: a capable and faithful person, having a strong inclination for all subjects connected with natural science.

The bay which has given its name to the town, is on an arm of Lake Michigan, about 120 miles in length, and its greatest width about 20 miles. It opens into the lake not so much by direct channels as by side ones among islands that lie across the mouth, which is about 25 miles in width. In general form it resembles the half-fledged wing of a bird attached to its body by its side and at the largest end. The general direction of its axis or middle line is northeast by north, making an acute angle with the coast line of Lake Michigan. A narrow peninsula coming to a point at the "Port-des-Morts," lies between the bay and the lake, rising from 100 to 200 feet above the water level. The western shore of the bay is low and swampy; winds that blow across the bay from the northwest, therefore, act more powerfully on its waters, locally considered, than those from the opposite quarter over the bluffs of the eastern shore. At Green Bay and Fort Howard the shore lines approach to a point.

From Mr. Underwood's register I have to a considerable extent condensed the readings so as to express them in substance, in the form of curves. At the broken or dotted portions the observations are wanting. We assumed an arbitrary line or plane of reference intended to be above the floods of the year 1858, and called this *zero*.

Constructing a water-gauge, marked to half inches, it was nailed to a pile at the south side of the dock of Day & Brothers, its zero corresponding with the assumed line, the figures reading downwards. The readings were made hourly during the day, but were necessarily deficient for most of the nights.

By means of the tables and of the diagram [see Plate] the written portion of this article is very much abridged.

Two columns at the left show the time of high water, and approximately the hour of the moon's southing on the same day. The period which should elapse between the meridian passage and high water is subject to so many collateral influences that it is not determined without long continued observations. But for the same place it must be nearly constant, and a tide arising from that cause would therefore occur with regularity. The space occupied by the corresponding strength and direction of the winds, as observed locally, exhibits only their prevailing or general condition.

On the 22d of September only four hours passed without observations, but most of the days began at 5 A. M. and closed at 7 P. M.

The position of Green Bay is more favorable for detecting a lunar tide, if it exists, than a point on the shore of the lake. In inland seas of much greater size, such as the Baltic and the Mediterranean, which connect directly with the ocean, only a small tide is observed. I am not aware that it has been noticed in the Caspian and the Black Seas. On the open sea the rise and fall is slight, ranging from two to three feet only.

The great vertical range of tides in our harbors on the coast arises from the configuration of the shore and the form of the ocean bed. The swell is augmented of necessity as it is driven into bays and inlets with converging shores and shallow water. At the mouth of the Bay of Fundy the tidal wave has thus been raised to 10 and 12 feet, and running into the bay it attains a height of 30 and 40 and at spring tides of 60 feet. The contour of Green Bay is much the same. A swell of two inches at the Port des Morts when carried on and compressed between the converging shores should produce a rise of six or eight inches.

It has been long known that on the western lakes there is a land and water breeze occurring daily, as happens on the coast of the ocean. Its regularity may be disturbed by storms, but without these a breeze begins gently to draw off shore between seven and eight in the evening, sufficient to take vessels out of harbor. About ten in the morning following, the reverse is witnessed. In the cold months, a sluggish, but damp and chilly, current of air moves from the water towards the land. It is productive of congestion of the skin, oppresses the lungs, produces torpor in the animal system, and increases the flow of blood to the head. The evening breeze has the opposite effect. Without assuming, in the present state of the observations, that the moon produces no perceptible effect on the waters of the lakes, I offer some deductions that I think follow from the register of Mr. Underwood, showing a direct connection between the winds and the rise and fall at Green Bay.

This effect is complicated but may be philosophically explained. A land breeze commencing at the Port-des-Morts, would in due time press the waters into the bay, more or less according to its duration and force. A water or off-land breeze would depress the water, but owing to the form of the bay and the coast the effect should be less in amount. These breezes are regular.

The winds and gales that occupy the whole surface of the lake, are irregular in their occurrence. They overcome in many cases the minor currents that flow and reflow across the shore line otherwise daily, to and from the land. These limited currents arise from the unequal heat of the day and of the night. Suppose a powerful norther is raging on the lake, driving the navigator towards its southerly extremity, where the chances of

shipwreck are at least equal to those in favor of his escape. The gale carries the water along with it, and at Chicago and Michigan City there is a rise in the surface of three to four feet. At the Beaver Islands and at the Port-des-Morts there is a corresponding depression. The waters of Green Bay must therefore tend to flow out. But the same wind operating within the basin of the bay, resists the flow of water to the north, and diminishes the result that would otherwise follow, depressing the surface at the town of Green Bay. A gale from the east and northeast acts in *favor* of a rise, both directly and indirectly. Its tendency is to force more water into the bay and to retain what is already there. Accordingly we should anticipate very high water under the influence of prolonged northeasterly winds. But even here as I witnessed at the Oconto River, November 2d and 3d, 1858, a reflux may occur while the wind holds in the same quarter. On the 2d at noon the water was at its greatest known height. At noon on the 3d it had fallen 12 inches although the same gale continued.

Gales from the south and southwest should produce hydrographical effects the reverse of those from the north, and have the same double action. If they continue long, the water in the lake is raised at its northerly end, and tends to flow into the bay, raising its surface. Within the area of the bay, however, the tendency is to drive water out of it, and to depress the surface at the mouth of the Fox River. Here is again the question of the resultant of opposing forces.

The diagram and its attendant columns show a direct connection between the northeast winds and the extreme floods of the season. The 2d of July, the 20th, 21st and 27th of August, the 8th, 9th and 24th of September, and the 2d and 3d of November are cases of this sort.

But to present this part of the subject more fully I insert a table of the extremes of both the ebb and the flood during 29 days which have the fullest record. [See table, next page.]

From this table it appears that in all cases where the force of the wind during the day reached 2 and over, there was a *difference of level* of eight inches or more, with the exception of Sept. 1st, when it was only 6½ inches. The wind that day was southerly. There is one case (Sept. 9th) of a range of 8 inches where the force of the wind (northeast) was only 1. In another case (Sept. 25th), where the record of the previous day was not taken, there was a fluctuation of 10½ inches without any wind observable at the town of Green Bay. Observations on the coast are necessary to elucidate such cases. On the 25th also there was a range of 9 inches under similar circumstances.

By the registers, there were 17 days in which the flood occurred *twice*, having two maxima, and 15 days with but one.

gh water occurred in the forenoon 18 times and in the after-on the same number. Low water took place in the forenoon imes and in the afternoon 12. With the wind northerly, of east and west line, high water occurred 12, and with it south-y 5 times. There was a flood in calm weather 10 times, and ebb 8 times.

Extremes of fluctuation for August and September, 1858.

	HIGH WATER.		WIND.		LOW WATER.		WIND.		Daily range.
	Hour.	Below zero.	Direction.	Force.	Hour.	Below zero.	Direction.	Force	
g. 19.	6 A. M.	3 inches.	Calm.	0	2 P. M.	12 inch.	S.W.	2	9 inch.
" 20.	6 A. M.	3½ "	"	0	5 "	16½ "	N.	2	13 "
" 21.	9 P. M.	4½ "	W. by N.	1	12 M.	13¾ "	W.	2	9½ "
" 22.	6 A. M.	0½ "	N.	1	2 P. M.	12 "	N.	1	11½ "
" 23.	6 "	4 "	W.	1	12 M.	14½ "	W.	1	10½ "
" 24.	6 "	9 "	Calm.	0	1 P. M.	15½ "	N.	1	6½ "
" 25.	7 "	8 "	S.	1	2 "	13 "	S.	1	5 "
" 26.	6 "	7 "	Calm.	0	3 & 5 P. M.	13 "	S.	1	6 "
" 27.	6 & 9 A. M.	1 "	N.	3	2 & 3 "	11½ "	N.	3	10½ "
" 28.	5 P. M.	1 "	N.	2	11 & 12 P. M.	9 "	N.	2	8 "
pt. 1.	7 & 9 A. M.	8 "	S.	1	5 A. M. & 2 P. M.	11 "	S.	1	3 "
" 2.	6 P. M.	5 "	S.	2	4 P. M.	16 "	S.	3	11 "
" 3.	9 A. M.	11 "	S.	2	1 "	20½ "	S.	3	9½ "
" 4.	5 P. M.	9½ "	S.W.	1	9 & 10 A. M.	20 "	S.W.	2	10½ "
" 6.	4 "	7½ "	S.	2	1 P. M.	14 "	S.	2	6½ " *
" 7.	5 "	5 "	N.	1	12 to 2 P. M.	14 "	N.	3	9 "
" 8.	6 A. M.	3, A	N.	2	4 P. M.	13 "	Calm	0	16 "
" 9.	8 A. M. to 7 P. M.	5, B	N.E.	1	5 A. M.	13 "	N.E.	1	8 "
" 10.	5 & 6 A. M.	5 "	W.	1	4 & 5 P. M.	17 "	W.	2	12 "
" 13.	11 A. M. & 7 P. M.	9 "	S.	1	5, 6 & 7 A. M.	13 "	Calm	0	4 "
" 14.	12 M.	8 "	Calm.	0	5 to 9 A. M.	10 "	"	0	2 "
" 15.	5 A. M.	8 "	"	0	12 M.	11½ "	"	0	3½ "
" 16.	5 "	7½ "	"	0	11 A. M. to 1 P. M.	13 "	"	0	6½ "
" 20.	6 P. M.	6 "	S.W.	2	10 A. M. to 12 M.	18 "	S.W.	3	12 "
" 22.	7 "	3 "	Calm.	0	2 A. M.	13½ "	Calm	0	10½ "
" 23.	7 "	2 "	"	0	2 P. M.	14 "	N.	1	12 "
" 24.	3 A. M.	4½ A	N.E.	4	7 "	15 "	Calm	0	19½ " †
" 25.	8 "	3 B	Calm.	0	6 A. M.	12 "	"	0	9 "
v. 2.	2 P. M.	15 A	N.E.	Gale.	‡				

bstract of the number of times high and low water occurred under the influence of different winds.

	North.	N.W.	West.	S.W.	South.	East.	N.E.	S.E.
igh water, - -	6 times	0	2	2	5	0	10	0
ow water, - -	7 "	0	3	3	6	0	8	0

High at 7 and 8 A. M. and 5 P. M. ‡ At 7 A. M., 12 A, at 12 M. 14 inches, A.
Gale from N.E. began at midnight, 23d and 24th.

From the 1st to the 16th of September inclusive, the moon's southing occurred within the hours of the readings for high and low water. Of these days, on the 1st and 3d the flood arrived within *two* hours after the passage of the moon. On the 2d, 4th, 6th and 7th from 5 to 11 hours afterwards. On the 8th, 9th, 10th, 12th, 13th, 14th, 15th and 16th from 5½ to 11½ hours before southing, but on the 9th and 13th there were two maxima 3 to 5½ hours after. From the 12th to the 15th inclusive, four days, the weather was continually calm at the place of observation. The variation of level during those days was small, the mean being *four* inches, the least 2, and the greatest 5½ in. This was the most favorable opportunity for the appearance of a lunar tide. The period of conjunction passed on the 7th, and consequently the calm weather all came within the first quarter. Neither on those days or during the most quiet periods embraced in Mr. Underwood's register, do I discover evidences of a flux and reflux that I can connect with the moon's motions.

Perhaps more perfect and prolonged observations might disclose such evidence. No station can be found better calculated to test the question fairly, provided simultaneous observations are made at the mouth of the bay. It is to be hoped the attention which the officers of the United States Topographical Corps are now giving to the subject of lake fluctuations will lead to such observations.*

ART. XXXIII.—*On Parthenogenesis*;† by E. REGEL.

THOUSANDS of accurately observed cases bear evidence that an embryo can be developed in a seed only under the influence of fecundation. A few naturalists did, indeed, up to the beginning of the present century, deny the necessity of fecundation, but these were solitary voices (Schelver and Henschel‡). The theory of fecundation, the practical proof of it (the production of hybrids), was assumed to be a settled fact, and up to our own time underwent a continually fuller development.

A few voices were here and there raised, not against the theory of fecundation generally, but for the proposition that in certain plants a true embryo might be formed without fecundation, where this was hindered; in other words, it was assumed that, "*Normally, the embryo is developed in a seed only under the influ-*

* See an Appendix to this paper in the miscellanies beyond.

† Botanische Zeitung, Oct. 8, 1858. Translated by Arthur Henfrey, F.R.S., &c. Cited from the Ann. and Mag. of Nat. Hist. xiv, 100.

‡ Henschel, von der Sexualität der Pflanzen, nebst einem historischen Anhange von Dr. F. J. Schelver. Breslau.

ence of fecundation. But if the fecundation is prevented, in certain cases an embryo may be nevertheless developed." Strictly speaking, therefore, it was assumed in this statement that the male sexual organs of plants were wholly superfluous structures.

But this assertion was made always in reference only to particular plants, and indeed to the same with which Spallanzani had experimented in the year 1786, namely hemp and spinach.* How inexact Spallanzani's observations must have been, appears from the fact that he obtained ripe seeds even from basil from which he had removed the anthers, also from watermelons, &c.

On these latter and similar plants, on which it is easy to operate, there exist a number of direct experiments to show that the prevention of fecundation hinders the production of seeds capable of germination; these and similar observations have been repeated subsequently by persons who were wholly destitute of the knowledge requisite for an exact experiment. On the other hand, Bernhardi, an otherwise very exact observer, repeated Spallanzani's experiments on hemp,† and obtained exactly similar results.

This question then sank to rest again; Bernhardi's observations were explained by assuming inaccurate observation, or the formation of a bud in the seed.

In 1841, J. Smith‡ made known his observations on the production of seed by *Cælebogyne ilicifolia*, which was stated to perfect all its seed without any fecundation. At the same period Lecoq asserted the occurrence of parthenogenesis in a host of plants. From his superficial observations he drew the conclusion that all annual plants with separate sexes could form perfect seeds without fecundation. By such a wise contrivance, nature prevented the dying-out of such plants.

Cælebogyne is still in very few hands in flowering condition. So far as we know, it has not been observed, from the period of flowering to the ripening of the fruit, by any German botanist. Observations on the so-called unfecundated seeds, such as were made by Radlkofer, Klotzsch, and A. Braun, can have but a conditional importance. That all has not been seen that may be seen, in this plant, is evident from the fact that while Klotzsch demonstrated, from the formation of the seed of this plant, that it contained not an embryo at all, but a bud, Radlkofer and A. Braun are of the opposite opinion. The latter, however, made a most important observation, still unexplained by him, namely, that he found a pollen-grain with a pollen-tube on the stigma of *Cælebogyne*.

* Spallanzani, Expériences pour servir à l'Histoire de la Génération des Animaux et des Plantes. Geneva, 1785.

† Otto und Dietrich, Allg. Gartenzeitung, 1839, pp. 327, 329.

‡ Trans. Linnæan Society of London, 1841, p. 509.

In leaving *Cœlebogyne* to one side, since those only are competent to speak of it who have had an opportunity to observe it, it may be noticed that this plant has been the cause of the resuscitation of the question as to the possibility of parthenogenesis in the vegetable kingdom, and this the more that a similar phenomenon in the animal kingdom was simultaneously asserted by von Siebold. Naudin and Decaisne in particular took up again the earlier experiments on *Spinacia* and *Cannabis*, adding to them a number of other plants. The result of their experiments was, that female plants of *Spinacia*, *Cannabis*, *Mercurialis annua*, and *Bryonia dioica* bore perfectly ripe seeds when they had been sufficiently guarded against the accidental influence of the pollen of male flowers. According to M. Naudin's report, neither he nor M. Decaisne could discover male flowers among the female flowers, which were borne in great numbers. On the other hand, *Ricinus communis* and *Ecbalium Elaterium* bore no seed when all the male flowers were removed before they opened.

Naudin concluded from his observations "*that only diœcious plants are capable of perfecting seeds without fecundation, while monœcious plants perfect their seed only under the influence of fecundation.*"

Radlkofer, from the cases made known by Naudin and Smith, deduced the further law, "*that ovaries which perfect their embryos without fecundation retain their stigmas much longer in a fertilizable condition than is the case when the embryo originates in consequence of regular fecundation.*"

As usual, the majority of naturalists have accepted these statements, promulgated as certain facts. The very circumstance that, in the supposed discovery, all those laws which we have invariably recognized in reference to the origin of embryos are opposed face to face—the attraction of the wonderful, which in these days possesses a powerful charm,—has brought many over to the party who believe in a parthenogenesis.

The author of this notice has expressed, in the last year or two ('Bonplandia,' 'Gartenflora'), his modest doubt as to the accuracy of the experiments of Naudin and Decaisne, which served as the basis of an hypothesis of so great weight.

An objection arose in the outset, from the fact that the result was obtained only in small-flowering plants which developed a mass of flowers in every leaf-axil, while large-flowering plants, like *Ricinus* and *Ecbalium*, bore no seed when fecundation was prevented. Still more striking was it, that, of plants known to be polygamous, only female plants were mentioned, and an assurance was given that no male flowers were observed upon them.

I have in the present summer repeated the experiments made by Decaisne and Naudin. Although they are not yet quite concluded, they have afforded me proof that Decaisne and Naudin

have observed but superficially, and that neither *Spinacia* nor *Mercurialis* are to be included among plants which can furnish proof of parthenogenesis.*

Plants of *Spinacia*, *Mercurialis annua*, and *Cannabis* were planted singly in pots; and the male plants were removed as they appeared, before the dehiscence of the earliest anthers. The female plants were kept in a place where no pollen from similar plants could have access to them. As soon as the first flowers were perfectly developed, they were cut away so as to leave only a few axillary inflorescences which could be easily examined. All newly-produced lateral branches, which were abundantly developed, were carefully removed, and the inflorescences of the plants experimented on observed daily with a lens. These observations refer, up to this period, only to *Mercurialis* and *Spinacia*, as *Cannabis* has not yet unfolded any flowers.

Mercurialis.—One of the female plants was placed in a different locality, where it grew freely without being cut. This plant has now set abundance of fruit, which will doubtless bear perfect seeds with embryos. But on examination it was found that solitary perfectly developed male flowers were produced in the axillary tufts of flowers, as can be testified by MM. Körnicke, Rach, and Maximowicz, to whom I showed them. How this escaped the observation of MM. Naudin and Decaisne, is beyond my comprehension.

Two plants of *Mercurialis* were cut in and observed in the above described manner. Each of the few tufts of blossom produced a great number of female flowers. Here, again, solitary male flowers continually made their appearance, so that I have already removed more than twenty of them from each of the experimental plants. Even with the most careful observation, an absolutely conclusive result could scarcely be obtained with this plant; for the male flowers are only detected after they have opened, and therefore may have scattered pollen. I used my utmost endeavors to suppress the male flowers at the right time; and in fact hitherto neither of the experimental plants have set fruit, all the earliest developed female flowers having withered up. But if these plants should still set fruit, this must be attributed to pollen received from some of the male flowers.

Spinacia.—Difficult as it is in *Mercurialis* to neutralize the influence of pollen from adventitiously developed male flowers, it is still more difficult with *Spinacia*. All the experimental plants were cut in. I observed at first, in the axillary tufts of female flowers, solitary normally developed anthers, which projected over the female flowers. I removed them, and placed the plants

* I have not yet full observations upon *Cannabis;* but this will doubtless furnish similar results.

on which I had noticed them in a different locality. All my experimental plants appeared inclined to set seeds. I therefore placed all except one, on which the first flowers were beginning to unfold, in another situation, and continued the examination of this plant with redoubled attention, allowing in all only ten axillary tufts of blossom to come to perfection. All newly-produced lateral branches were necessarily broken off, as these at once developed new blossoms. First of all, I observed on this plant two stamens with anthers containing abundance of pollen. Placed under the microscope, this exactly resembled normal pollen. These stamens, however, did not arise (as I observed in *Chamærops* last year) from female flowers; but among the female flowers were scattered solitary stunted male flowers, which brought only one stamen, seldom more, to perfection. This fixed my attention. With the help of the lens, I soon saw, in the tufts of female flowers, isolated gland-like bodies, which I had taken at first for misshapen bracts. When I had dissected them out, I found that they were *sessile anthers*, developed in scattered abortive male flowers. These contained perfect pollen, as the above-mentioned gentlemen as well as myself can testify. These anthers are seldom perfectly seen, but are almost always partly covered up by the involucral scales of the flowers in which they arise, so that they may be easily overlooked or be taken for transformed bracts. In the isolated male flowers I usually found one sessile perfect anther, with several abortive; more rarely several perfectly developed anthers filled with pollen (all, however, sessile) exist in one flower. From one single axillary inflorescence I dissected out ten such male flowers with sessile perfect anthers. But as this had to be done on living plants under a lens, it could seldom be effected without injuring the anthers, by which pollen was always scattered. In such cases, I indeed removed the immediately adjacent female flowers; and the withering away of the earliest female blossoms was the result. At present, however, several appear to be swelling into fruit.

The very abundant development of axillary flowers here is of course a result of the cutting back of the plant and the removal of the lateral shoots which continually break out afresh from the axils, since the formative energy is wholly diverted to the development of flower-buds. A large proportion of the experimental plants did not bear this injury, and soon died away.

Whether the experimental plants of *Spinacia* and *Mercurialis* perfect seeds capable of germination, or not, these experiments have already fully convinced me that these two genera only develop perfect seeds under the influence of the pollen of adventitious male flowers, and that the only possibility of preventing fecundation is by daily repeated observation of every single

flower that unfolds, limitation of the growth of the plant to a few tufts of inflorescence, and rightly-timed removal of each male flower which makes its appearance. An observer who merely looks over a number of female plants with thousands of little flowers, cannot possibly obtain any result of the slightest scientific value. Surveying therefore the conclusions drawn from these experiments, it becomes evident that they have no authority.

That *Ricinus* and *Ecbalium* perfected no seed, evidently arises from the fact that in these plants the male flowers may be easily enough detected in time and removed, which can scarcely be accomplished with certainty in *Mercurialis* and *Spinacia*, since, from the small size and close packing of the flowers, these can only be detected when too late, even if these flowers are not altogether overlooked. There is no ground for making a distinction between monoecious and dioecious plants in this respect.

The same is the case with the stigmas. All the flowers of my experimental plants that were really protected from fecundation soon withered, stigma included. When, on the other hand, fruit was formed in consequence of fecundation, the stigmas persisted a long time, which is by no means wonderful, considering the fleshy nature of the stigmas of these plants.

As soon as *Cannabis* flowers, this plant shall also be subjected to careful examination. I may be permitted to notice beforehand, that the results of previous observations on *Cannabis* have been very varied. Some obtained no seeds on separate female plants (Linnæus obtained this result); others obtained abundance of seed. It seems to be indicated by this, that in *Cannabis* there occur individuals bearing only female flowers, and others which may resemble those of *Spinacia* or *Mercurialis*.

We possess plants of *Cœlebogyne;* but, unfortunately, none of them have yet flowered. Yet I am convinced that in this plant careful observation will clear up the matter. I may refer to the peculiar glands which surround the female flowers, with which solitary imperfect anthers might be easily confounded.*

Parthenogenesis certainly does not occur in plants with evident sexual organs.

Petersburg, Aug. 13, 1858.

* The author does not appear to be aware that the characters of the male flowers of *Cœlebogyne* are well known. M. Baillon has proposed the same unsatisfactory explanation of this case.—A. H.

ART. XXXIV.—*Terrestrial Climate as influenced by the Distribution of Land and Water at different geological epochs;* by HENRY HENNESSY, F.R.S., M.R.I.A., Professor of Natural Philosophy in the Catholic University of Ireland.*

EVERY point on the earth's surface is continually gaining and losing heat, and its actual temperature at any given moment depends on the difference between its gains and its losses. If the outer coating of the earth were exclusively composed of solid materials, terrestrial climate would depend principally on the heat gained from sunshine and the heat radiated into space. But as the earth is completely enveloped by an atmosphere, and partly surrounded by a liquid, its thermal conditions must be greatly influenced by the physical properties of these fluid coverings. While the heating or cooling of a solid follows the clearly defined and comparative well understood laws of conduction and radiation, the heating or cooling of gases and liquids is further greatly modified by the mobility of their particles. The changes of state which frequently take place in fluids, whether by evaporation or condensation, freezing or liquefaction, introduce agencies which still further complicate the study of their thermal relations.

When we study the thermal conditions of a liquid distributed over the terrestrial spheroid, it becomes manifest, that these conditions are influenced by the area, configuration, and physical structure of such portions of the solid earth as rise above the ocean and come in contact with the atmosphere, so as to constitute the surface of the dry land. Upon this matter I propose to develop certain views which are closely connected with those I have already published relative to the distribution of heat over such solid surfaces.†

2. When a surface, covered with ordinary soil, receives the rays of the sun, the heat thus acquired passes downwards, but on arriving at a very small depth its intensity rapidly diminishes. The solar heat which is thus received by the ground may, therefore, be considered as confined almost entirely to a thin superficial stratum. The air in contact with the soil becomes heated, expands, and tends to ascend: a circulation thus follows between the upper and lower strata of the atmosphere situated above the heated ground. During the night a different process takes place; for then the radiation of the soil causes its temperature

* Cited from the Atlantis, for January, 1859.

† On the Distribution of Heat over Islands, etc., Atlantis, No. ii, p. 396. See also the Note on the Laws that Regulate the Distribution of Isothermal Lines, No. iii, p. 201.

to fall below that of the superincumbent air; the coldest stratum of the lower portions of the atmosphere being in contact with the ground, the equilibrium of those above is not so much disturbed. Yet, even in this case, causes exist which tend to produce a series of actions and reactions between the upper and lower strata of air, by which a process of convection will be ultimately developed. These actions will be rendered especially remarkable if the soil is not bare, but covered with vegetation in the manner of the greater part of the dry land. This question has been fully treated by Melloni,* in his memoir on the nocturnal cooling of bodies. His general proposition, that "a body exposed during the night to the influence of a sky of equal clearness and calmness, is always cooled to the same extent, whatever may be the temperature of the air," is fruitful in important results. Thus is explained the great differences between the temperature of the day and night on land in the torrid zone. The intense cold observed during the night by Denham in traversing the great Desert of Sahara, the process of artificial freezing at Bengal, and the rain-like dews observed by Humboldt in the forests of South America, are all necessary consequences of the energy of the actions and reactions by which the outer coating of the earth loses the warmth it has acquired from sunshine during the day. Conversely, the almost constant temperature of the sea in tropical regions, by day and night, and the nearly total absence of dew on the rigging of vessels far removed from the land, clearly show the peculiar retentiveness of heat possessed by the water, and that, unlike the land, it does not readily part with whatever warmth it may have acquired from sunshine during the day. The cold southerly breezes sometimes observed in Egypt† during the winter months, when the air has passed over immense surfaces of sandy desert, present a striking contrast to the southwesterly winds which at the same season traverse the ocean and visit our shores. It appears, from a communication in the *Times* newspaper, dated Melbourne, November 15, 1858, that in South Australia, the coldest winds during the winter months, are those blowing from the northerly and tropical regions, while the warmest are those blowing from the pole. The former pass over extensive surfaces of heat-radiating, and therefore heat-losing land, while the latter traverse the heat-retaining ocean. In the summer (at least by day) the opposite phenomena are observed, of warm winds from the north and cold from the south. Combined observations on the wind, and on temperature, by day and night, would further elucidate a problem which, in the words of the writer, "cannot be solved

* Taylor's Scientific Memoirs, vol. v, pp. 458 and 530; and Annales de Chimie et de Physique, for February and April, 1848.

† Kaemtz Metéorologie, French edit., p. 45.

without greatly adding to the stock of our knowledge." While the feeble conducting power of the solid portion of the earth's coating, allows but a small portion of the sun's heat to pass beneath the surface, so that whatever warmth is thus received on that surface during the day is readily radiated into space during the night, a liquid mass, similarly exposed to sunshine and subsequent nocturnal radiation, possesses peculiar properties which greatly influence the differences between its thermal losses and gains. The most important of these properties are, (1) the great capacity of water for heat, by which it gradually accumulates and slowly parts with whatever warmth it has received; and (2) the intermobility of its particles, by which exchanges of temperature in different parts of the liquid mass are essentially promoted.

Let us consider the effect of the sun's rays on a globe covered with water, and we shall soon perceive that a more energetic process than that of conduction accompanies the exchanges of temperature between the different portions of the fluid. The water which receives the vertical rays of the sun will be more heated than the waters which receive its rays at more oblique inclinations. Not only the amount of warmth received over a given area, but also the depth to which the rays of heat penetrate below the surface, depends upon the angles made by these rays with the vertical. Inequalities of surface temperature, depending on the latitude, the hour angle, and the sun's longitude, should thus result. The more heated waters would expand, and tend to spread over the cooler waters in other regions. Currents should arise from the mutual actions and reactions of the unequally heated portions of the fluid. The colder currents would usually tend to flow beneath the warmer, unless at temperatures approaching that of the maximum density of water, and thus a process of circulation would be established by which the temperature acquired by the superficial strata of the water should be ultimately propagated to a certain depth below the surface. Evaporation would also take place, and by the condensation of vapor a certain portion of the heat received by the water would be imparted, in the formation of clouds, to the superincumbent atmosphere.

If, as in the existing oceans, this water be salt, the inequalities of temperature producing inequalities of evaporation, will also produce diversities in the density of the water in different regions, and thus additional energy will be imparted to the process of circulation. The salter and heavier surface water will tend to sink into the colder liquid which lies beneath, and which shall naturally tend to take its place, by ascending upwards. The process of evaporation would cool the surface of the water; but, unlike that of radiation, it is not altogether a losing process

as far as the entire surface of the earth is considered; for it is sooner or later followed by condensation, whereby the greater part of the absorbed heat is again returned. When a piece of land or water parts with its heat by radiation into space, that warmth can never be restored to any part of the earth's surface; but whatever heat the water loses by evaporation, becomes latent in the vapor so produced, and is ultimately transferred by condensation to some other part of the globe; and hence evaporation does not constitute an agent in causing a diminution of general terrestrial temperature. Let us now suppose a sheet of water at the equator nearly surrounded by fixed boundaries, so as to form a species of immense lagoon. Its temperature, from the causes here referred to, will rapidly augment. The heat which it has acquired during the day shall have penetrated so deeply as to be incapable of being radiated backwards into space during the night, with the same facility as on the surface of a sandy plain or from the summits of a mass of vegetation. Its temperature should thus continue to accumulate up to a certain limit imposed by the conditions of evaporation, and it might ultimately attain a mean temperature superior to any which is now met at the surface of intertropical seas.

3. These views are strikingly illustrated by the phenomena accompanying the origin of the Gulf Stream. The mass of water which rushes into the Gulf of Mexico, along the southern shores of the Carribbean Sea, has already acquired a certain elevated temperature from the action of sunshine in the southern torrid zone in its passage from Cape St. Roque. In moving around the Caribbean Sea and the Mexican Gulf, these waters still continue under the influence of a tropical sun, and are constantly increasing in temperature. The islands and coasts which they happen to bathe, have no part in directly promoting this augmentation. On looking over the isothermal chart of the Caribbean Sea and Gulf of Mexico, prepared by Mr. Charles Deville,* it becomes manifest that in general the temperature decreases in going towards the land. In some places the mean annual temperature of the water close to the land is 24°·5 Centigrade; further out at sea it is 25°, and still further from the land it is 25°·5. In other places it gradually augments from 26°, in going from the land, up to 27°·4.† These results are unconnected with the influence of latitude, and they are still less explicable by the influence of centrifugal force, in driving the cooler and heavier waters towards the edges of the great current, in its semi-rotatory movement around the gulf. For in this case the law of decrease of temperature in going from the

* Annuaire de la Société Météorologique de la France, tom i, p. 160.

† Reduced to degrees of Fahrenheit's scale, these numbers, arranged in the same order as in the text, are 76°·1, 77°·0, 77°·9, 78°·8, 81°·3.

land, should not hold on approaching the coasts of large islands situated towards the centre of the moving mass of waters. But, in such instances, it is also manifested; for on the north and south coasts of the Island of Cuba we find the isothermal lines of 26°·2 and 26°·5, while the isothermals of 26°·7 and 26°·8 are situated outside them respectively.* In Mr. Deville's chart these are closed isothermals, similar to those which I have indicated on the surface of the British Islands; but as the lowest isothermals in my map are the most remote from the sea, those in his chart which exhibit the highest temperature are farthest from the land. It is thus apparent that the intertropical sea may become a storehouse of heat, by retaining much of what it receives from the sun, which, but for the physical properties of water, it would, like the intertropical land, lose by radiation into space. It is important to bear this conclusion in mind in any inquiries respecting the influence of the distribution of land and water on general climate, especially as the influence of the land seems to have been hitherto principally considered as a calorific agent.

The heating action of intertropical land has been so often discussed by writers on climate, that it is unnecessary to do more than to point out its principal agency in the production of aerial currents, by which exchanges of temperature may be promoted between different parts of the earth's surface.

In contrasting the mean temperature of the sea with that of the land in tropical climates, the want of nocturnal observations, as referred to by Melloni, is peculiarly felt. While the temperature of the one is nearly constant, that of the other is liable to considerable fluctuations; and, as our records are principally derived from diurnal observations, the results are probably too favorable to an excess of land temperature. This conclusion is confirmed by the results exhibited in Mr. Deville's map, and, in some measure, by the fact of the higher mean temperature of the entire oceanic covering of our planet compared to its atmospheric coating.

In comparing the calorific influence of the land on distant regions with the agency of the sea, it should therefore be remembered, that while the latter stores up heat and acts by night as well as by day, the action of the land is effective only as long as the sun's rays are impinging upon it.

4. Let us endeavor to apply these conclusions to the question of the influence of the distribution of land and water upon general terrestrial temperature. As the amount of solar heat received by any point on the earth's surface is a function of the latitude, it follows that the distribution of land and water at different latitudes must be studied in order to obtain its influence

* Equivalent respectively to 79°·16, 79°·7, 80°·06, and 80°·24 of Fahrenheit's scale.

ι temperature. This distribution may be supposed to take ace in an endless variety of ways, of which the following ree cases are the most important:—

(1.) Preponderance of land towards the poles, and of water wards the equator. (2.) Preponderance of land towards the [uator, and of water towards the poles. (3.) Equable distribu- ɔn of land and water in polar and equatorial regions.

At the present day three-fourths of the earth's surface are ›vered with water, so that all the dry land has been truly char- :terized as an assemblage of large and small islands placed in great ocean. If we suppose, with Sir Charles Lyell,* that in .e question now under consideration, the proportion of sea to nd is the same as at present, each of the above three cases is ısceptible of two principal divisions, according as the islands ›mposing the land happen to be few and large, or numerous ıd small. If all the dry land on the globe were collected into single vast continent, the climatological conditions of the earth, l other things remaining the same, would be very different om what would take place if the land were broken up and ›read out in numberless islands. Whatever may be the sup- ›sed distribution of land and water, it is manifest that its chief fluence on the general temperature at the surface of our planet, ıould result from the action of aerial and oceanic currents.

In the first case above referred to, the belt of equatorial ocean ould probably acquire a high temperature, and although the rcumpolar islands would possess very rigorous climates in their terior, portions of their coasts might be washed by heat-bear- g currents, just as the northwestern coast of Europe is washed r the Gulf Stream at the present day. The superiority of the .ean temperature of the ocean might, in this case, be so great ıat the distribution of heat over the islands should present re- arkable instances of the laws found to hold good in the British ıles, and almost all of the isothermals on the land would be osed curves.†

In the second case, the ocean would acquire much less heat om the sun, and it would exercise a cooling influence on the ɜlt of intertropical land. But as whatever evidence we possess ems to indicate that intertropical seas owe their elevated tem- ɜrature not so much to the influence of thermal exchanges with .e air which has passed over the adjacent land, as to the direct fluence of sunshine, we may conclude that upon the whole the ɜat-bearing currents would, in this case, be less influential than that which has just been considered. The heated air flowing om the equatorial land should, by the agency of winds, in some

* Principles of Geology, chap. vii, 9th ed., p. 101.

† See Atlantis, No. ii, p. 399.

measure mitigate the temperature of the polar regions, but we have no reason for believing that this influence would be superior to that of the heat-bearing water currents in our former instance.

If now we suppose the land to be equally distributed in islands between the equatorial and polar regions, we shall have conditions more or less favorable to the existence of oceanic as well as of aerial heat-bearing currents, and it seems not impossible that, under such circumstances, the entire surface of the globe may enjoy the highest possible amount of general warmth by being best circumstanced for the accumulation, retention, and distribution of the heat it receives from the sun. In this case, as well as in the first which has been considered, warm currents from the equatorial seas might freely bathe the coasts of islands in higher latitudes, thus producing similar characteristic cases of insular climate. The mean temperature of such seas being higher than that of the air over the land, the isothermal lines of the islands should be partly or entirely closed curves, having shapes dependent upon the outlines of the islands. The greater the difference of atmospheric and water temperature, the more strictly should the isothermals conform to this law. Thus it is manifest that a nearly circular island, with a surface equal to that of Labrador, and lying in the same latitude, would present a much greater diversity of climate between its interior and its coasts, if the latter were bathed by sea water having a temperature of 80° Fahrenheit, than if that temperature amounted only to 40°. As the manner in which the warm air over the water would exchange its heat with the air over the land should take place undoubtedly by circulation, it would not be easy to assign a distinct law for the difference of temperature between the interior and the coast of the island; but it seems evident that this difference should, up to a certain limit, increase with the temperature of the heat-bearing oceanic currents. A group of islands situated in high latitudes, and surrounded by currents possessing a high temperature, while receiving but a small amount of heat from sunshine, should present a series of closed isothermals, and while their interiors would be cold, their coasts might enjoy an extremely genial climate.

5. If such conditions existed at former geological epochs, we may fairly expect to find some evidence of their existence by comparing the characters of the organized beings by which the interior and the coasts of such islands were inhabited. Such geologists as have hitherto studied the diversities in structure of the fossil remains which have come under their notice, appear to have attended principally to the climatic influence of the elevation of the interior parts of such islands. Professor Ramsay,*

* Memoirs of the Geological Survey of Great Britain, vol. i, p. 324.

in his memoir on the denudation of Wales, after pointing out the great elevation above the sea, which portions of that region had formerly possessed, calls attention to the resulting varieties of climate that must have prevailed. "If," he says, "the climate of our latitudes, when the coasts were washed by the new, red, and liassic seas, were tropical, as is generally supposed, still on the heights indicated on the vertical sections, we have ample space for tropical and temperate zones, each probably abounding in its own appropriate forms of life. And here, in connection with this subject, it may be remarked, that in Mr. Brodie's recent work, 'A History of the Fossil Insects of the Secondary Rocks of England,' it has been stated that, with certain exceptions, the minute size of the great mass of the insect remains seems to indicate a very cold, or at all events, a temperate climate."

This appeared to Professor Ramsay not to be in harmony with the other fossil evidence, which proves that most of the creatures whose remains are preserved in the strata of the secondary series inhabited a tropical climate. If the interior temperature of the land, whose inhabitants apparently existed under such different conditions of climate, depended not only on the coördinate of height above the sea, but also on that of distance from the coast, in the manner here described, a more complete explanation would be afforded of these remarkable phenomena. The discovery by Mr. Strickland, in the alluvial sand of Worcestershire, of the bones of a hippopotamus, accompanied, not only by the bones of other mammalia, but by twenty-three species of fresh water and land shells, of which nineteen are existing British species, seems to show that, even at a period so recent as that of the deposit from which these remains were taken, remarkable differences of climate may have existed over a comparatively small area of land.* The strong presumptions furnished by the fossil flora, and other evidences connected with the history of earlier geological formations in favor of the existence of numerous islands scattered over an ocean enjoying a tropical temperature, should lead us to expect more of such results as are here noticed, instead of feeling surprise at the discrepancies which they seem to exhibit.

6. I shall now attempt to illustrate some of the preceding general views from the actual condition of the earth's surface. The higher mean temperature of the northern, compared to the southern hemisphere, is clearly proved and universally acknowledged. This superior warmth is usually ascribed to the greater amount of land in the former compared with the latter. It has been apparently assumed that the surface of the dry land exercises upon the whole a far more energetic influence, in tending

* Geological Society's Proceedings, June, 1884, p. 94; and Lyell, p. 76, 9th edition.

to elevate the mean temperature of the earth, than the surface of the water, and this action is generally ascribed to the superior heat-absorbing power of land compared to water. Upon this assumption is mainly founded the beautiful and elaborate theory of geological climates, which Sir Charles Lyell first published in his *Principles of Geology.* Although Fourier had previously indicated the possible influences exercised upon terrestrial temperature by the physical conditions of the earth's outer coating, he had not given his views such a definite shape as to enable him to deduce any conclusions from them for the solution of the great problems of terrestrial physics which have so much occupied the attention of philosophical geologists.

If the conclusions of the theory now referred to be correct, it follows that predominance of land over water between the tropics, where an absorbing surface would be most advantageously circumstanced for acquiring heat, should result in producing the highest possible degree of general terrestrial temperature. On the contrary, the earth's general climate would be reduced to a maximum of coldness by a predominance of land towards the polar regions, and of water towards the equator. The views developed in this essay would appear to require some modification in these conclusions, and the first especially is not in perfect harmony with the results to which we have been led by such reasonings as I have here presented. Not only are there physical grounds for adopting a somewhat different conclusion, namely, that the most favorable condition for a generally high terrestrial temperature would be in a comparatively equable distribution of land and water over equatorial and extratropical regions, instead of a concentration of land in the former; but the study of the present relations of sea and land seems strongly to verify the views on which this conclusion is based.

If we look over a terrestrial globe, or a good stereographic projection of its surface,* we soon perceive that in the regions traversed by the ecliptic, and where, consequently, the sun's rays diffuse the greatest amount of heat over absorbing substances, land and water are distributed very evenly at both sides of the equator. Each hemisphere absorbs the greatest quantity of solar heat during the six months when the sun is vertical over some part of its surface, and I have found that the parallel of 7° 24′ receives the maximum amount of sunshine during the summer half year. In the northern hemisphere this parallel runs from the coast of Guinea through Central Africa; crossing the Indian Ocean, south of Cape Comorin, it passes through Ceylon across Malacca and the island of Mindano; thence through

* M. Babinet's homolographic maps are still better adapted for such comparisons as that now made. See Arago Astronomie, tome iii, p. 344, Report of the British Association for 1856, Trans. Sections, p. 112.

the Pacific, until it meets South America, the northern portion of which it traverses from a point near the Gulf of Panama to another between the mouths of the Orinoco and Esiquibo. In the opposite hemisphere, the parallel of maximum southern sunshine crosses Africa from a point north of St. Paolo de Loando to another near the Monfeca islands. It traverses a great part of Java, New Guinea, and smaller islands. It crosses South America almost on the line of greatest breadth, from near Truxillo to a point north of Pernambuco. On comparing the extent of land and water lying under the parallel of maximum half-yearly sunshine, it appears that the proportions are nearly the same in both hemispheres, although a very slight excess of land appears to lie under the southern, compared to the northern parallel.* Outside the torrid zone, the proportions of land and water belonging to each hemisphere respectively are extremely different: while nearly half of the surface between the pole and the tropic of Cancer is land, by far the greater portion of the area between the southern tropic and the pole is water. In the arctic and antarctic regions land and water alternate in nearly corresponding proportions. The great difference between the areas of land and water of the northern and southern hemispheres exists in the temperate regions. Upon the whole, it may be concluded, that there is a comparative predominance of land over water in the higher latitudes of the northern hemisphere, while the opposite condition holds in the southern hemisphere. If the presence of dry land in high latitudes is favorable to a cold climate, this condition appears to be more completely manifested in the northern than in the southern hemisphere; and if the presence of a certain amount of dry land within the tropics is favorable to a high temperature, that condition is almost equally well fulfilled at both sides of the equator.

Let us conceive all the land north of the equator to be submerged, and its place to be supplied, first, by a mass of land in the north tropical zone, exactly similar in area and configuration to that touching it in the southern zone. Let the arctic regions of North America, Nova Zembla, and Greenland be replaced by an island similar to Victoria Land, and let a few scattered islands replace the greater part of Asia, Europe and North America: we shall then have a globe with a considerable belt of equatorial land, while the polar and temperate regions will be occupied chiefly by water. We should thus have a state of things approximating much more to the conditions required for a high terrestrial temperature than the present distribution of land and water. Yet the distribution here supposed for both hemispheres would be precisely what at present exists in the colder of the

* See p. 328, Art. XXXIV, On the Laws which Regulate the Distribution of Isothermal Lines, § 5.

two; and we should thus have the paradox of warming the entire globe by modelling its warmer hemisphere after its colder. Unless the influence of Victoria Land as a refrigerator of the southern hemisphere should be greater than that of the immense masses of land in the northern parts of the new and old continents, this paradox would seem inexplicable on the theory under consideration. But it can be in some measure explained, if the agency of oceanic currents in storing up and transporting the heat acquired from sunshine be fully admitted. In the actual state of the earth's surface, the form of the basin of the South Atlantic Ocean, combined with other physical conditions, seems to determine the transfer of a great volume of heated water from the southern intertropical regions to the northern hemisphere, which, passing subsequently through the Caribbean Sea and Gulf of Mexico, acquires a still higher temperature, and ultimately confers its warmth on regions in high northern latitudes. From the direction of the currents of the Pacific, as laid down on some of Maury's charts, it is probable that a similar transfer northwards of heated southern intertropical water is effected in that great ocean as well as in the Atlantic. The general result is, that the southern hemisphere is not only deprived of a certain amount of the solar heat absorbed by its waters, but that the temperature of the northern hemisphere is augmented to a corresponding amount. But although the paradox alluded to may be thus explained, this result shows the danger of underestimating the agency of aqueous currents in connection with any theory of the distribution of land and water that may be proposed in order to explain vicissitudes of terrestrial climate.

7. In examining the consequences resulting from the suppression of the Gulf Stream on the climate of western Europe, with reference to the question of glacial action at former geological epochs, as has been done by Mr. Hopkins,* we need only direct our attention to what actually takes place at corresponding latitudes in the southern hemisphere. In these regions, there is not only an absence of such an active calorific agent, but even an abstraction of some of the heat due to them from the sunshine which falls upon a portion of their oceans, which heat we have seen is transferred to the northern hemisphere. Glaciers consequently descend to the sea, not only about the latitude of 54° S., as observed by Captain Cook, but even so close to the equator as 48° 30′ S., where they were noticed in great abundance on the western coast of South America by Mr. Darwin.† He even observed one instance of a glacier reaching the sea in the latitude of 46° 40′, which corresponds to that of Napoleon Vendée, in the west of France. The existence of glacial action in the

* Quarterly Journal of the Geological Society, 1852, p. 85.
† Voyage of Adventure and Beagle, iii, p. 282.

southern latitudes, equivalent to those of the temperate regions of western Europe, suggests the possibility, that by an inversion of the operating causes, the southern hemisphere might have enjoyed a milder climate at the same geological period when glacial phenomena were most completely developed north of the equator.

8. The results of our inquiry may be thus recapitulated:—

(1.) The physical properties of water appear upon the whole more favorable than those of the land, to the accumulation, retention, and distribution of solar heat throughout the matter composing the external coating of the earth.

(2.) Phenomena presented by intertropical seas at the present day, confirm and illustrate this conclusion.

(3.) The distribution of land and water most favorable to a general increase of terrestrial mean temperature, should, therefore, be such as would imply the existence of great intertropical seas and of groups of islands evenly distributed both within the tropics and in extratropical regions.

(4.) Such a distribution of land and water at former geological epochs, seems to be indicated by the results of observation.

(5.) The superior mean temperature of the northern compared to the southern hemisphere is probably due, not to the direct influence of the greater proportion of land in the former, but to currents which determine the transfer towards the north of a portion of the solar heat absorbed south of the equator.

9. While fully acknowledging the important influence which changes in the distribution of land and water may exercise on terrestrial climate, we are not precluded from studying the action of other causes, and of giving to them such weight as the evidences in their favor may render advisable. If, from the results of astronomical as well as of geological testimony, we are induced to believe that the earth has been for ages slowly cooling from a state of former incandescence, its climate during the earlier epochs of its physical history must have been more or less influenced by the heat thus passing outwards through its crust. However efficient, as applied to recent phenomena, we may find the theory of geological climates that explains the variations of the earth's superficial temperature by changes in the distribution of the liquid and solid portions of its outward coating, it seems by itself incompetent to rationally and consistently account for the very high temperature which must have prevailed during remote epochs of the earth's history. If we reject the evidence on which it has been concluded that the earth has slowly cooled from a fluid incandescent state into its observed condition, and admit that the earth's spheroidal shape was due to gradual and even existing causes, and not to the mechanical consequences of its primitive and universal fluidity, we shall arrive at a conclu-

sion which, on the supposition of the complete adequacy of superficial causes to explain all changes of climate, would lead to the inference that, from very remote epochs, the mean temperature of the globe should be increasing instead of diminishing. By rejecting the former fluid condition of the earth, we are compelled to account for its oblateness in the way attempted by Playfair, that is, by appealing to the influence of certain superficial actions coexisting with the phenomena of geological changes. But I have proved,* that if, from superficial causes, the earth's figure became gradually more oblate, the extent of polar dry land would gradually diminish, while that of equatorial dry land would, at the same time, tend to augment. Hence the very operations required to mould the earth's figure into the shape now observed, would, on this theory, point to a gradual increase in the efficiency of the physical conditions required for an augmentation of terrestrial temperature in proceeding from the most remote to the most recent geological epochs. But this is the very reverse of the conclusions deduced from the entire mass of geological inquiries; hence, as far as observation enables us to judge, we cannot explain by superficial actions alone, the twofold conditions of the spheroidal shape in the earth's figure, and the gradual diminution of its surface temperature from the earliest periods of geological history up to the most recent.

ART. XXXIV.—*Note on the Laws which Regulate the Distribution of Isothermal Lines;* by HENRY HENNESSY, F.R.S., M.R.I.A., Professor of Natural Philosophy in the Catholic University of Ireland.†

IN my essay on the Distribution of Heat over Islands,‡ I referred to another mode of treating the general problem of isothermal lines, by which similar conclusions are derived. As these conclusions are not only obtained by a method somewhat different from that already published, but as they are accompanied with a few additional remarks relative to their connection with the climatology of the globe, I may be permitted to present the following investigation as a development of a portion of the former inquiry.

2. The general problem, whose solution is here attempted, is to find the influence exercised by the physical structure and hydrographical relations of an island on the temperature at its surface. Let us consider an island having a certain definite figure,

* Proc. Royal Irish Academy, vol. iv, p. 333, and Journal of the Geological Society of Dublin, March, 1849.

† Cited from the Atlantis for January, 1859.

‡ Atlantis, vol. i, p. 399.

and surrounded by an ocean so warm that we may at first neglect the influence on its climate of the difference of latitude of the several parts of its surface. Let it be supposed perfectly free from hills or mountains, land breezes will tend to blow from the interior, and sea breezes from every point on the coast. The disturbing action of other winds would sometimes greatly modify the directions and intensities of the land and sea breezes; but, abstracting for a moment the effect of such general winds, it is evident that the temperature at any point of the island due to the action of the warm air flowing in from the ocean, and of the cold air flowing from the interior, will be some function of its distance from the coast, and, consequently, the forms of the isothermal lines should have some relation to the coast line. If no other winds blew over the surface of the island but land and sea breezes, and these with uniform intensity and frequency at every point, the isothermal lines should be similar to the coast line. Let us now superimpose on the island a series of elevations sufficiently considerable to offer impediments to the currents of wind: the forms of the isothermal lines will undergo important changes. If these eminences are scattered around the coast, their influence shall be greater than if they were all concentrated towards the interior of the island; for, in the former instance, they will present a kind of barrier, more or less broken, between the air resting on the central plains and the air outside covering the ocean. The sea breezes will no longer exercise the same effect on the portions of the interior situated behind the mountains, while their influence will remain unchanged, or be even increased, on the portions still unscreened from the ocean. A corresponding change must, therefore, take place in the forms of the isothermal lines. They should approach the coast at the parts screened by the mountains, while they should remain stationary, or sometimes recede towards the interior, at the intervals between the mountains. If the interior of the island does not consist entirely of dry plains, but is covered with lakes and considerable areas of undrained marshy land, such evaporating surfaces will cool the surrounding air. If the evaporating surfaces be concentrated chiefly about the centre of the island, their influence will not be much felt at the coast, and thus, although they may produce some local changes in the forms of the isothermal lines in their neighborhood, their most important effect will be to render still more decisive the differences of temperature on a line drawn from the coldest region at the centre to the coast; in other words, to contract or enlarge the dimensions of some of the isothermals.

3. If the influence of the differences of latitude of the surface of the island be now considered, it can be demonstrated that its

tendency will be to transport the centres of the isothermals towards the pole, in whatever hemisphere the island may be situated, and that the isothermals at the centre shall be more affected from this cause than those at the coast. Let us suppose, for precision, the island in the northern hemisphere.

Let us at first abstract the effect of all other sources of terrestrial temperature but solar radiation, and consider the proportions of heat that may be received by two elements of the surface of the island included between two adjacent isothermal lines. It will suffice to determine the quantities for the spaces included between each of their northern and each of their southern extremities respectively. From the great distance of the sun, its rays may be supposed nearly parallel, and from the limited area we are considering, the earth's figure may be supposed perfectly spherical. By the laws of radiant heat, the amount of heat received by an element s of the surface of the earth, will be represented by*

$$\frac{s\,G\cos\varphi}{R^2}.$$

G being a coefficient, independent of the state of the earth's surface, and expressing the amount of heat that passes from the sun to a unit of surface placed perpendicularly to the direction of the sun's rays at a certain unit of distance, φ the inclination of the sun's rays to a perpendicular to the plane of the element s of the earth's surface, and R the radius of the earth's orbit. But

$$s = a^2 \cos\lambda\, d\lambda\, d\mu,$$

where a is the earth's radius, λ the latitude of the point where the element s is situated, and μ its longitude. But in the spherical angle whose sides $\frac{\pi}{2}-\delta$, $\frac{\pi}{2}-\lambda$, include the angle ψ, which subtends φ, we have

$$\cos\varphi = \sin\lambda\sin\delta + \cos\lambda\cos\delta\cos\psi,$$

where δ is the sun's declination, and ψ an angle depending on the hour of the day, being included between the meridian of the element and that of the sun. The problem now before us, being connected with the proportional quantities of sunshine received by different elements and not with the absolute amounts, we may in a first approximation consider these quantities as proportional to the amount received at noon; consequently for a limited area of the sphere the quantity of heat received in the time dt is proportional to

$$\frac{G a^2}{R^2}\iiint \cos(\lambda-\delta)\cos\lambda\, d\lambda\, d\mu\, d t.$$

* Poisson Théorie Mathématique de la Chaleur, No. 210.

But if u represents the mean longitude of the sun, and P the rameter of the earth's orbit, we should have

$$R^2 du = \sqrt{P} dt.$$

ıt also

$$\sin \delta = \sin i \sin u,$$

eing the inclination of the equator to the ecliptic: therefore above expression becomes

$$\frac{a^2 G}{\sqrt{P}} \left\{ \iiint \cos^2 \lambda \sqrt{1 - \sin^2 i \sin^2 u}\, du\, d\lambda\, d\mu \right.$$
$$\left. - \iiint \sin i \sin u \sin \lambda \cos \lambda\, du\, d\lambda\, d\mu \right\}$$

The limits between which the integrations for μ and λ are to effected, will depend on the figure of the surface under con- .eration. For simplicity, let it be an extremely small portion the surface of the island included between two meridians, so ›se to each as to include a nearly rectangular space between ›ir segments and those of the two isothermal lines. If m be › breadth of the rectangle, we may take μ from o to m, and λ ›m λ_2 to λ_1, λ_1 being the latitude of the northern extremity of ıichever of the isothermals is nearest the coast, and λ_2 the lati- le of the northern extremity of the other isothermal. The ›a under consideration will be $m(\lambda_1 - \lambda_2)$. The sun's longitude nust be taken from 0 to 2π in estimating the amount of solar at received during a year.

4. The heat received by the element $m(\lambda_1 - \lambda_2)$ from the influ- ›es of causes, independent of direct solar radiation, will, as eady stated, be a function of the distance of this element ›m the coast; it will therefore be a function of the difference its latitude and that of the nearest point on the coast. If we ıke $\lambda_1 + \lambda_2 = 2A$, and represent the latitude of the northern rt of the coast nearest the element of surface by l, we shall ve for H the proportion of heat received by the element dur- › a year, the expression

$$H = f(l - A)$$

$$\frac{a^2 G m}{2\sqrt{P}} \left\{ [\tfrac{1}{2}(\sin 2\lambda_1 - \sin 2\lambda_2) + \lambda_1 - \lambda_2] \int_0^{2\pi} \sqrt{1 - \sin^2 i \sin^2 u}\, du \right.$$
$$\left. - \tfrac{1}{2}(\cos 2\lambda_2 - \cos 2\lambda_1) \sin i \int_0^{2\pi} \sin u\, du \right.$$

The second of these integrals vanishes between the limits, ı the first may be determined by the properties of elliptic ıctions for

$$\int_0^{2\pi} \sqrt{1 - \sin^2 i \sin^2 u}\, du = 4 \int_0^{\frac{1}{2}\pi} \sqrt{1 - \sin^2 i \sin^2 u}\, du$$
$$= 4 E(i).$$

$E(i)$ representing a complete elliptic function of the second order,* whose modulus is i. The value of i being 23° 28, $E(i)$ $=1\cdot50658$: consequently we may ultimately write

$$H=f(l-A)$$

$$-3\cdot01316\frac{a^2G}{\sqrt{P}}m\left\{\sin(\lambda_1-\lambda_2)\cos(\lambda_1+\lambda_2)+\lambda_1-\lambda_2\right\}$$

But as $\sin(\lambda_1-\lambda_2)=\lambda_1-\lambda_2$, very approximately, this may be written,

$$H=f(l-A)+C(1+\cos 2A)$$

where

$$C=3\cdot01316\,a^2G\frac{m(\lambda_1-\lambda_2)}{\sqrt{P}}.$$

Similarly H, the proportion of heat received by the very small and nearly equal area included between the southern extremities of the isothermals, may be written

$$H_1=f(l_1-A_1)+C_1(1+\cos 2A_1)$$

where

$$C_1=C\frac{(\lambda_3-\lambda_4)}{\lambda_1-\lambda_2},\qquad 2A_1=\lambda_3-\lambda_4$$

and $l_1=$ the latitude of the nearest point of the southern coast of the island. $f(l-A)$ and $f(A_1-l_1)$ are both positive, and both are supposed, in virtue of what has been already stated, to possess the property of varying inversely with $l-A$ and A_1-l_1 respectively; in other words, $f(l-A)$ increases when $l-A$ diminishes, and $f(A_1-l_1)$ increases when A_1-l_1 diminishes. If we divide H and H_1 by the nearly equal areas $m(\lambda_1-\lambda_2)$ and $m(\lambda_3-\lambda_4)$ respectively, the results will represent the amount of heat received by the units of surface at the northern and southern extremities of the isothermals. These quantities should be equal; hence we shall have, very approximately,

$$\cos 2A+f(l-A)=\cos 2A_1+f(A_1-l_1);$$

But as $\cos 2A<\cos 2A_1$, it follows that $f(l-A)>f(A_1-l_1)$, and, consequently, $l-A<A_1-l_1$. If the influence of solar radiation were not considered, these quantities would be equal: consequently its tendency is to transport the closed isothermal line from south to north, by making the distance of its northern extremity from the northern coast less than the distance of its southern extremity from the southern coast. The same result will affect the next adjacent isothermal, and so on in succession, so that ultimately all the isothermal lines will be transported towards the north.

As

$$C(1+\cos 2A)=2C\cos^2 A,$$

* Poisson gives 0·17798, as its logarithm from Legendre, Théorie de la Chaleur, p. 490.

the heat received at any point of the earth's surface from solar radiation alone, abstracting the influence of atmospheric absorption in different latitudes, varies in conformity with Mayer's law as the square of the cosine of the latitude.

The more the influence of latitude predominates over all other causes, the more will the positions of the isothermals be changed in the manner above indicated: it follows, therefore, that while towards the equatorial coast of an island these lines terminate on the coast, they may still continue as closed curves in the interior of the island. If the influence of differences of latitude was greatly predominant over all other climatic influences, all the isothermals may terminate on the coast.

5. The quantity of heat received by a given small area during the summer and winter half-years, between the spring and autumnal equinoxes, may be readily found by integrating with respect to u, within the limits 2π and π, and afterwards within the limits π and 0. Thus we shall have the general expression

$$\frac{a^2 G m}{p^{\frac{1}{2}}}\left\{[\cos(\lambda_1+\lambda_2)\sin(\lambda_1-\lambda_2)+\lambda_1-\lambda_2]\,E(i)\right.$$

$$\left.\pm 2\sin i \sin(\lambda_1+\lambda_2)\sin(\lambda_1-\lambda_2)\right\} \qquad (4.)$$

the term affected by $2\sin i$ is to be taken with the positive sign for that half of the year during which the sun is at the same side of the equator as the area in question, and the negative sign for the other half of the year. If $\lambda_1-\lambda_2$ be so small that its square may be neglected, then for the small area $s=m(\lambda_1-\lambda_2)$ we shall have the amount of solar heat H_1 received during either half year expressed by the equation

$$H_1=K(E(i)\cos^2 A\pm\sin i\sin 2A),\ \text{making}\ K=\frac{2a^2Gs}{p^{\frac{1}{2}}} \qquad (5.)$$

$\sin 2A$ is always positive, as A cannot exceed 90°, it follows, therefore, that the influence of latitude on the points of the isothermals will be greater during the summer half of the year than during the winter half; and therefore, all other things remaining the same, the isochimenal lines, or lines of equal winter temperature, would be less displaced from their concentric position in an island than the isotheral lines, or lines of equal summer temperature.

From the preceding expression we can determine the latitude of the parallel which receives the greatest amount of solar heat during the summer half of the year. For on differentiating we have

$$\frac{dH}{dA}=K(\sin i\cos 2A-E(i)\sin 2A),$$

This equated to zero gives

$$\text{tang.}\, 2A = \frac{\sin i}{E(i)} \qquad (6.)$$

Also, $$\frac{d^2 H}{d A^2} = -2K \left\{ \sin i \sin 2A + E(i) \cos 2A \right\}$$

If in (6) we substitute the values of $E(i)$ and $\sin i$ respectively, we shall find $A = 7° \ 24'$ nearly, $\cos 2A$ and $\sin 2A$ will both be positive, and therefore $\frac{d^2 H}{d A^2}$ negative; the above value of tang. $2A$, gives therefore a maximum value to H, and consequently the parallel which receives the greatest amount of solar heat during the half year that the sun is at the same side of the equator, is the parallel which has the latitude $7° \ 24'$.

6. The results of these investigations become applicable to the two great continents of the eastern and western hemispheres; for as these are both completely surrounded by water, they may be considered as two immense islands. The distance from the ocean of the greater part of their surfaces, diminishes so much the action on their general climate of the waters by which they are surrounded, that the influence of difference of latitude becomes as a general rule, predominant over all other causes, and the centres of most of their isothermal lines are transported so far towards the pole, that many of these lines circumscribe the earth's axis, or lie in surfaces which cut that axis more or less obliquely.

In the interior of a continent, an elevated table-land of limited dimensions is circumstanced nearly in the same way as an island, for its edges are surrounded with air having a mean temperature nearly uniform, and different from that lying on its surface. We may therefore expect to find, even in the interior of continents, closed isothermal lines, as well as in the interior of oceanic islands.

The disturbing action of general winds will modify the forms of the isothermal lines, according to the frequency and the temperature of these winds. The warm winds will cause the isothermals to recede from the coast towards the interior in a direction opposed to that from which they emanate; the cold winds will, on the contrary, cause the isothermals to advance towards the direction from which they blow. We may, therefore, conceive the tendency of such general winds, when warm, to be to remove the centres of the isothermals from the points whence they blow; when cold, their tendency will be to approach these centres towards the same points. If we compound these tendencies with the effect of differences of latitude, we would have the resultant direction towards which the isothermal lines should be displaced from their concentric position by the action of all these disturbing causes.

ART. XXXVI.—*On the possible Intersection of the orbits of Mars and certain of the Asteroids;* by Professor DANIEL KIRKWOOD, of the Indiana University.

THE present eccentricities of the asteroidal orbits are included between the limits 0·046085 and 0·336987. Of these, some are increasing, others diminishing. We are not aware, however, that the range of variation has, in any instance, been accurately determined. If we assume the superior limit of the eccentricity, in the case of the following members of the group, to be 0·25, (and this is less than the *present* eccentricity of Juno, Phocæa, Polyhymnia, and Atalanta,) their perihelion distances at the epochs of maximum eccentricity will be as follows:

Flora,	1·650940
Ariadne,	1·652379
Harmonia,	1·700361
Melpomene,	1·722045.

The present *aphelion* distance of Mars is 1·665725, the eccentricity of the Martial orbit is, however, increasing; the secular variation being 0·000090176. According to LeVerrier the maximum eccentricity will be 0·14224. The corresponding aphelion distance will be 1·740431; greater than the *least* perihelion distances of the asteroids above named. It is obvious therefore that if the longitudes of Mars and any one of these bodies should differ by nearly 180° when the eccentricities of both are not far from their superior limits, the orbits or at least their projections on the plane of the ecliptic, *must intersect.* When it is remembered that the variation of the eccentricity is extremely slow, that the line of apsides of the orbit of Mars completes a revolution in less than 20,000 years, aud that the inclinations of the orbits of Flora, Harmonia and Ariadne, are small, the probability of a very near approach of Mars and some of these small planets—an approach so close as to render the question of the perturbations of the latter both curious and interesting—is at once apparent. If we assume the greatest eccentricity *now* found in the group, as the superior limit of the variation of *all*, the maximum *aphelion* distance of Mars will be greater than the minimum *perihelion* distances of twenty of the small planets.

Bloomington, Ind., Feb. 11, 1859.

ART. XXXVII.—*Contributions to the History of Euphotide and Saussurite;* by T. STERRY HUNT, of the Geological Survey of Canada.

1. The name of euphotide was originally given by Haüy to a rock composed of diallage and a white compact mineral which he designated as *feldspath tenace*, (the compact feldspar of Werner, the lemanite of Delamétherie, and the jade of de Saussure senior). The well-marked contrast of colors which suggested the name of euphotide is seen in the beautiful *verde di Corsica* or *verde antico di Orezza*, and in some varieties of the rock from Mt. Rose. In these the diallage is represented by a grass-green smaragdite, and this mineral and hypersthene being regarded by Haüy as varieties of diallage, he included under the head of euphotide, the *verde di Corsica*, (for which alone d'Halloy retains the name of euphotide,) the hypersthenite or hyperite of other authors, and the granitone of the Italians. This last by an error of Von Buch, in which he has been followed by Gustav Rose, is very frequently called gabbro. The true gabbro of the Italians is however a diallagic ophiolite. (Brongniart, *Classif. des Roches*, 1827, p. 75.)

Brongniart defines euphotide to be a mixture of diallage with jade, petrosilex, or compact feldspar, and including d'Halloy's two species, euphotide and granitone, but excluding hyperite, he distinguishes as varieties, jadian and feldspathic euphotides, besides ophitic (serpentinous) and micaceous euphotides, the latter being sometimes talcose.

Coquand (*Traité des Roches*, 1857,) has followed Haüy with regard to the euphotides, while Senft (*Die Felsarten*, 1857,) places in one group, under the head of hyperite, three genera, eclogite, gabbro, and hypersthenite, in the second of which he includes rocks made up of labradorite or saussurite with diallage or smaragdite. The eclogite of Haüy is composed of diallage or smaragdite, and red garnet; it often holds disthene (cyanite) through the predominance of which it passes into disthenite (disthenfels), while hypersthenite or hyperite (hypersthenfels, G. Rose) is a mixture of saussurite or labradorite with hypersthene (d'Halloy, Senft.).

Distinctions like some of the above based upon the contained varieties of pyroxene are evidently of secondary importance, and it becomes necessary to define with more strictness the nature of the other element of the rocks in question. The jade of the Swiss Alps to which de Saussure junior, afterwards gave the name of saussurite, was described by de Saussure senior, as compact, tenacious, greenish-white in color, hard enough to scratch quartz, and having a specific gravity of 3·318—3·389.

Mohs gives 3·256 for the density of a granular saussurite from Peidmont, and 3·34 for a compact variety from the Canton of Vaud, while Naumann assigns to the mineral a density of 3·40. These authors thus agree in ascribing to saussurite a specific gravity much above that of the feldspars.

Klaproth and de Saussure junior, both analyzed specimens of the saussurite from the shores of the Lake of Geneva (lemanite, I and II) while Boulanger subsequently examined the saussurite from the euphotide of Mt. Genèvre (III), and from two localities in Corsica, the valley of Orezza (IV) and the banks of the Fiumalto (V).

	I.	II.	III.	IV.	V.
Silica,	49·00	44·00	44·6	43·6	34·0
Alumina,	24·00	30·00	30·4	32·0	24·4
Peroxyd of iron,	6·50	12·50	....	....	....
Lime,	10·50	4·00	15·5	21·0	31·8
Magnesia,	3·75	....	2·5	2·4	6·4
Soda,	5·50	6·00	7·5	....	....
Potash,	....	·25	....	1·6	....
	99·25	96·75*	100·5	100·6	96·6

The physical and chemical characters of the above specimens offered considerable differences. The saussurite II. is described by de Saussure as leek-green, subtranslucent, with an oily lustre, and a finely granular, scaly fracture; it scratched quartz and had a density of 3·261. At a high temperature it fused without loss of weight, into a glass much softer than the original mineral, and having a density of only 2·8. This saussurite, which was free from any admixture of smaragdite, was scarcely attacked by boiling sulphuric acid.—(*Journal des Mines,* vol. xix, p. 205, A. D. 1805.)

The saussurite from Mt. Genèvre (III) according to Boulanger is associated with a greenish-brown smaragdite, and is itself greenish-white and compact, not scratched by the knife, and having a density of 2·65. He describes another euphotide from the same locality as having a lamellar base, with cleavages like feldspar, sometimes chatoyant, hard, not attacked by acids, and with a density of 2·58. The analysis of this undoubted feldspar gave him, silica 66·6, alumina 18·5, lime 1·8, soda 6·0, potash 4·3 = 97·2.

The euphotide of Orezza is described by Boulanger as composed of green diallage, a blackish matter also apparently a variety of diallage, and saussurite, the whole arranged in parallel bands, giving to the mass, which is very tough, a schistose fracture. The saussurite (IV) was very compact, less hard than III, and had a density of 3·18. It was easily fusible and not attacked by concentrated sulphuric acid.

* Besides 0·05 oxyd of manganese.

The euphotide of the Fiumalto consisted of green diallage with curved lamellæ in a white paste, which was tender, easily cut with a knife, and had a density of 3·30 (v). It was readily fusible and easily attacked by sulphuric acid, with which the analysis was made; the separated silica being dissolved by a solution of potash which left a residue, supposed to be diallage, and equal to 3·8 parts, which added to the above analysis makes the sum 100·4; alkalies were absent.—(*Ann. des Mines*, [3], viii, p. 159.)

Notwithstanding the peculiarities presented by saussurite, modern mineralogists have generally referred it to labradorite or some other feldspar, (see Beudant, Bischoff, Dana, Delesse, etc.). Jameson, separates it from the feldspars on account of its greater specific gravity, but recent authors seem to have entirely lost sight of this characteristic. Coquand describes saussurite as having a density of 2·87, while according to Delesse it is seldom inferior to 2·80. These authors agree in declaring the mineral to be decomposable by acids like labradorite, while Bischoff and Senft, without alluding to its density, assert that saussurite is not attacked by acids.

An analysis of saussurite by Stromeyer gives the composition of labradorite, while Lory on the other hand has described as euphotide a rock from Levaldens in the Dauphinese Alps, which is made up of an olive hornblende and a white mineral having the cleavage of a feldspar and the composition of andesine. —(*Bull. Soc. Geol. de France*, [2], vii, 540.)

Delesse examined the white base of a euphotide from Odern in the Vosges, and another from Mt. Genèvre. Both of these were highly crystalline and exhibited the polysynthetic macles of the feldspars of the triclinic system. When pulverized and treated with muriatic and sulphuric acids they swelled up and were decomposed. Delesse has however described them as saussurite. That from Odern gave him, silica 55·23, alumina 24·24, lime 6·86, magnesia 1·48, protoxyd of iron 1·11, soda 4·83, potash 3·03, water and volatile matters 3·05 = 99·83. The euphotide of Mt. Genèvre contained diallage, a serpentine-like substance, and a ferriferous carbonate of lime, besides the feldspar, whose crystalline laminæ were more than one-third of an inch in length, and gave by analysis, silica 49·73, alumina 29·65, lime 11·18, magnesia 0·56, protoxyd of iron 0·85, soda 4·04, potash 0·24, water and volatile matters 3·75 = 100·00. Of the volatile portion according to Delesse, at least 2·50 p. c. is water, the remainder being carbonic acid. (*Ann. des Mines*, [4], xvi, pp. 238 and 267.) This feldspar resembles that of the orbicular diorite of Corsica which gave to Delesse, silica 48·62, lime 12·02, alkalies 3·61, and 0·49 of water.

Under the name of saussurite von Rath has described a mineral which with hornblende (uralite) forms the greenstone of Neurode in Silesia. It had the hardness, cleavage, and crystalline structure of labradorite, but with a specific gravity of 2·99, and gave by analysis, silica 50·84, alumina 26·00, peroxyd of iron 2·73, lime 14·95, magnesia 0·22, potash 0·61, soda 4·68, volatile 1·21 = 101·24.—(*Pogg. Ann.*, xcv, 555.)

2. Accepting the view maintained by Rose, Bischoff and Delesse, that saussurite is nothing more than a feldspar, I referred to this species the compact feldspars of the Laurentian rocks of Canada, described in my report of 1854. Associated with the limestones and ophiolites of this most ancient geological series, is a great body of crystalline stratified rocks, composed essentially of anorthic feldspars, sometimes almost without admixture, but frequently associated with green granular or cleavable pyroxene, which passes through a kind of bronzite into hypersthene. Small quantities of epidote, garnet, and more rarely mica and quartz, are also met with, and magnetite and ilmenite are common. Different varieties of these rocks would be referred by lithologists to the species labradophyre, dolerite, and euphotide. The feldspars are sometimes very coarsely crystalline but often compact; they have a hardness of 6·0, and vary in density from 2·67 to 2·73, and in composition from andesine to vosgite. The denser varieties are those in which lime and alumina predominate; all of them contain besides soda small quantities of potash. The analyses of numerous varieties of these feldspars will be found in the Report cited above, and in the *L. E. and D. Philos. Magazine*, [4], ix, 262.

The euphotides examined by Delesse and Lory are apparently nothing more than varieties of dolerite, by which term we understand a rock composed essentially of a triclinic feldspar, with some variety of pyroxene, which may be augite, hypersthene, or diallage. According to G. Rose, smaragdite, which is the variety of pyroxene regarded as characteristic of euphotide, has often the external form of pyroxene with the cleavage of hornblende, constituting the variety uralite, while in the euphotides of Baste and Veltlin hornblende occurs with the diallage, and sometimes replaces it entirely, giving rise to a rock composed of saussurite and hornblende. Sandberger has observed crystals of pyroxene forming macles with others of hornblende, and the latter often surround the crystals of pyroxene, or as I have remarked in specimens from Madawaska, small crystals of deep green hornblende are implanted upon large prisms of greenish-white pyroxene. Smaragdite according to Hisinger and Delafosse consists of laminæ of pyroxene and hornblende united in a more or less regular manner. Since diorite is distinguished from dolerite by the substitution of hornblende for pyroxene, it

is evident that feldspathic aggregates like those of Baste present a transition from the one to the other species of rock.

Diorite is distinguished from diabase according to Senft by containing a feldspar insoluble in acids (albite or oligoclase,) and by the frequent presence of quartz, while in diabase the feldspathic element is less silicious and decomposable by acids; (labradorite or a variety approaching anorthite).* When however we consider the manner in which these feldspars pass into one another, this distinction between diorite and diabase seems of but secondary importance. We have seen that the orbicular diorite (or diabase) of Corsica contains a feldspar near anorthite in composition, while others in the Vosges, according to Delesse, contain labradorite and andesine, the latter with quartz. Lory has described a diorite from the crystalline schists of the mountains of Chalanches (Isère) which is made up of a chromiferous hornblende, with crystalline andesine and a pale greenish-yellow epidote often intimately mixed with the feldspar, and so abundant as to characterize the rock. This epidote gave by analysis, silica 40·6, alumina 30·2, lime 17·7, protoxyd of iron 11·2 = 99·7.

3. Diorites, as already mentioned, sometimes contain albite. Associated with the Silurian ophiolites of Canada we often find beds of rock which are mixtures of albite with hornblende or pyroxene, sometimes with small portions of carbonates. These diorites are tough, granular, sub-translucent, greenish or bluish-gray in color, weathering superficially to an opaque white and having a somewhat waxy lustre. Hardness 6·0; density 2·71—2·76. The hornblendic element is sometimes nearly amorphous, but at other times forms cleavable grains; by ignition these portions become darker, while the feldspar is rendered whiter and more opaque, and often exhibits striæ upon the cleavage surfaces.

A fine grained variety of this diorite from Orford was examined; it had a somewhat yellowish-green color and a subconchoidal fracture. After ignition the striated crystalline grains of feldspar were distinctly seen. The powdered rock does not effervesce with nitric acid, which appears to be without action upon it. The analysis gave as follows:

				Oxygen.
Silica,	68·60	63·40		33·81
Alumina,		12·70		5·93
Soda,		7·95		2·07
Potash,		·13		
Lime,	7·28	7·50	2·14	4·43
Magnesia,		3·37	1·35	
Protoxyd of iron,		4·23	·94	
Loss by ignition,		·40		
		99·68		

* See R. H. Scott, *L. E. and D. Phil. Mag.*, [4], xv, 518.

The oxygen ratios of the alkalies and alumina in the above analysis are very nearly as 1 : 3, and if to these we add the silica corresponding to twelve equivalents, or in round numbers to 24·00 of oxygen (equal to 45·00 of silica) we shall have 65·78 parts of albite, in which the oxygen ratios are 1 : 3 : 12. The oxygen of the remaining silica and protoxyds equal 9·81 : 4·43, showing a slight excess of silica over the proportion required to form a pyroxene.*

The feldspathic base of dioritic and doleritic rocks is sometimes even more silicious than albite, and passes into petrosilex, which may be regarded as a mixture of feldspar with quartz, or perhaps a distinct feldspar like krablite. Brongniart mentions petrosilex as sometimes forming the base of euphotide, and Thompson has described under the name of saussurite a mineral which occurs with diallage at the Lizard in Cornwall, having a density of 2·80, and yielding by analysis 82·0 p. c. of silica, besides alumina, lime, magnesia and oxyd of iron. In this connection I may cite from my report above referred to, the analyses of two varieties of petrosilex. The first (A) forms great beds among the ophiolite rocks of Orford; it is apparently homogeneous, somewhat translucent, very tough and with a scaly conchoidal fracture; it is distinguished from the diorites just described by the absence of the white opaque coating upon the weathered surfaces. Color greenish or grayish-white; lustre waxy, dull. Hardness 6·0; density 2·635—2·639. The second (B) from St. Henri, is a finely granular greenish rock, which occurs interstratified with shales and limestones in unaltered Silurian strata which are regarded as the equivalents of the ophiolitic series. It is somewhat less compact and tenacious than the last, which however, it closely resembles.

	A.	B.
Silica,	78·40	71·40
Alumina,	11·81	13·60
Soda,	4·42	3·31
Potash,	1·93	2·37
Lime,	·84	·84
Magnesia,	·77	2·40
Protoxyd of iron,	·72	3·24
Loss by ignition,	·90	2·50
	99·79	99·66

4. While engaged in the examination of the various feldspathic rocks which are associated with the ophiolites of Canada, I was constantly looking for some mineral whose hardness and specific gravity should correspond to those of the jade or saussurite of

* See for further analyses the Report of Geol. Survey of Canada for 1856, p. 458, in which the above analysis is calculated for the old equivalent weights of silica. In the present paper the equivalent of $Si\,O_2$, has been reckoned at 14+16 =30.

de Saussure and Mohs. At length I met with a very heavy rock which occurs with the ophiolites of Orford, and closely resembles an ophitic euphotide. It is made up of a white garnet having the aspect of saussurite, intermingled with a small amount of a soft green serpentine, which fills the interstices between irregular rounded masses of the garnet; portions of the latter mineral half an inch in diameter, are easily obtained in a state of purity. It is distinguished by a hardness of 7·0, and by its density, which for selected fragments, was found to be 3·522—3·536. It is amorphous, finely granular, and extremely tenacious, with a conchoidal fracture; lustre feeble, waxy; color yellowish or greenish-white; sub-translucent. After intense ignition, which did not however effect its fusion, the pulverized mineral gelatinized with hydrochloric acid. Its analysis was made after fusion with carbonate of soda, and gave:—

Silica,	38·60	38·80
Alumina,	22·71	
Lime,	34·83	
Magnesia,	·49	
Oxyds of iron and manganese,	1·60	
Soda and a trace of potash,	·47	
Loss by ignition,	1·10	
	99·80	

This mineral agrees closely in composition and properties with lime-alumina garnet, whose theoretical composition is represented by silica 40·1, alumina 22·7, lime 37·2 = 100·0. Croft obtained for a white garnet from the Ural mountains, having a density of 3·504: silica 36·86, alumina 24·90, lime 37·15 = 98·10.

At the falls of the river Guillaume in St. François, (Beauce,) there is also found a heavy rock which is composed in great part of garnet. It forms a bed in contact with an ophiolite, and has a somewhat variable aspect; in some portions it has a sub-conchoidal fracture with traces of crystallization; lustre shining, somewhat silky, color yellowish-white, sub-translucent. This variety, which is apparently homogeneous and exceedingly tough, has a hardness of 7·0, and scratches deeply the surface of agate; its specific gravity was found to be 3·333—3·364. It also occurs as a greenish-white or grayish-white somewhat granular rock, cavities in which are lined with small indistinct crystals; the density of this variety was 3·397—3·436.

Other specimens from the same locality exhibit the garnet intermingled with large cleavable masses of dark-green hornblende, which passes into a pearl-grey or lavender-grey variety. Small fragments of the garnet from this mixture had a density of 3·496; they were white, opaque, with a conchoidal fracture, and somewhat vitreous lustre. Intermingled with the garnet and hornblende, was another white or yellowish-white amorphous mineral, with a waxy lustre and a hardness of 6·0; the density

of a nearly pure specimen of it was 2·729, of another fragment 2·823. This, conjoined with its hardness, renders it probable that it is a feldspar; but it is very difficult to separate it from the garnet, or even to distinguish between the two species by the eye alone. Another specimen of a white granular rock from the same locality, which had been taken for garnet, had a density of only 2·800, and was supposed to be chiefly feldspathic in its nature. The specific gravity of the greyish hornblende was 3·046.

A specimen of the first described variety, having a density of 3·333 was selected for analysis; its powder did not effervesce with heated nitric acid, which however dissolved from it considerable alumina and lime. By the ignition of the rock, its yellowish color was only changed by the appearance of rare points of blackish-green. The analysis gave as follows:—

		Oxygen.
Silica,	44·85	23·69
Alumina,	10·76	5·03
Peroxyd of iron,	3·20	·96
Lime,	34·38	9·77
Magnesia,	5·24	2·09
Loss by ignition,	1·10	
	99·53	

If we suppose the alumina the peroxyd of iron and a portion of lime to form a garnet in which the oxygen ratios of the protoxyds, sesquioxyds and silica are 1 : 1 : 2, the residual lime and silica with the magnesia will be in the proportions requisite to form a pyroxene. We have lime 21·07, alumina 10·76, peroxyd of iron, 3·20, silica 22·69=57·72, with the oxygen content 5·99 : 5·99 : 11·98. There remains then for the pyroxene, lime 13·31, magnesia 5·24, silica 22·16=40·71, containing oxygen 5·87 and 11·71=1 : 2. The observed density of the rock corresponds very closely with that calculated for a mixture of lime-alumina garnet and pyroxene in the above proportions.—(*Geol. Survey of Canada*, Report, 1856, p. 449).

5. The great density of the above described garnet rocks and their association with hornblende, serpentine and feldspar, led me to suppose that similar rocks might have furnished to different chemists some of the discordant facts which are met with in the history of euphotide and saussurite. I have recently, however, through the kindness of Prof. Arnold Guyot, now of Princeton, New Jersey, had an opportunity of examining a collection of the euphotides of Switzerland, made by him in the course of his researches on the distribution of the erratic rocks of the basin of the Rhone. Prof. Guyot then traced the euphotides, which are found in scattered blocks and pebbles for a distance of nearly one hundred and fifty miles, to the valley of Sass, or rather to the corresponding chain of the Sassgrat, which forms a part of

Mt. Rose.* The euphotides of the Alps according to other observers are associated with protogine, ophiolites and crystalline schists.

I had now before me the original euphotides which had been studied by Haüy and de Saussure, and through the liberality of Prof. Guyot was furnished with numerous specimens of the characteristic varieties. Their examination has afforded me the following mineral species: saussurite, smaragdite, actinolite, talc, feldspar, and rarely pyrites.

The saussurite, which is generally predominant, is very uniform in its characters; it is always finely granular or compact, very tough, and with a sub-conchoidal or splintery fracture. Its color is white, passing into greenish bluish and yellowish-white, rarely with flesh-red stains; sub-translucent; lustre feeble, waxy. Hardness 7·0; scratches quartz. Specific gravity 3·33—3·38. A euphotide containing cleavable masses of smaragdite an inch in diameter, afforded me portions of bluish-white saussurite, apparently homogeneous, and having a density of 3·336—3·365. Another specimen of euphotide, containing a good deal of talc, and only small grains of smaragdite, had a density in the mass of 3·315, but selected fragments of the saussurite gave the number 3·385. Another large fragment of greenish-white saussurite had a specific gravity of 3·338, while a fourth specimen of euphotide holding only small lamellæ of smaragdite, and mingled with greenish-gray talc, had a distinctly granular texture, and a density of only 3·16—3·20.

The smaragdite of all these varieties of euphotide has a grass green color passing into emerald and olive-green. Lustre somewhat pearly; hardness 5·5; specific gravity of fragments from the first-mentioned euphotide, 3·10—3·12. The smaragdite generally exhibits only the cleavages of pyroxene, but in some cases it is irregularly penetrated by slender prisms of hornblende.

Talc is rarely absent from these euphotides, and is often abundant in small foliated or radiated masses, enclosed in the saussurite. The talc is generally silver-white, but occasionally appears greenish from the presence of minute crystals of dark green actinolite, which may be seen penetrating the talc, in close proximity to the yellowish-green smaragdite. The latter I have always found enclosed in the saussurite.

A bluish-gray or lilac feldspar is often met with in these euphotides, and is at once distinguished from the saussurite by its color, cleavage, translucency, vitreous lustre, and inferior hardness. I have not observed cleavage faces of this feldspar more than a fourth of an inch in length, although in some specimens it is rather abundant. Grains of it are sometimes imbedded in the talc, but it more generally occurs in the saussurite.

* See also Jas. Forbes, *Travels through the Alps*, p. 352.

This feldspar is completely decomposed by heated sulphuric acid, and contains a large proportion of lime, characters which show it to be labradorite or an allied variety.

Two specimens of saussurite were selected for analysis, the bluish-white variety from the first mentioned euphotide having a specific gravity of 3·365, (VI) and selected fragments of a greenish-white variety from the second, with a density of 3·385, (VII). This was penetrated by talc, from which it was impossible, completely to separate it. The eleutriated mineral was decomposed by prolonged fusion with carbonate of soda, the separated silica and alumina being in each case carefully analyzed. The alkalies were determined by J. Lawrence Smith's method of igniting with carbonate of lime and sal-ammoniac, and consisted of soda with but traces of potash. The results were as follows:

	VI.	Oxygen.	VII.	Oxygen.
Silica,	43·59	23·25	48·10	25·65
Alumina,	27·72	13·95	25·34	11·94
Peroxyd of iron,	2·61	·78	3·30	·99
Lime,	19·71	5·63	12·60	3·60
Magnesia,	2·98	1·19	6·76	2·70
Soda,	3·08	·80	3·55	·91
Loss by ignition,	·35	....	·66	....
	100·04		100·31	

Boiling concentrated sulphuric acid removed only traces of alumina and lime from the pulverized saussurite, which was however partially decomposed by this acid after having been strongly ignited.

The hardness and specific gravity of saussurite assign it a place with epidote. Rammelsberg has recently published the analyses of six varieties of lime-alumina epidote or zoisite, varying in density from 3·25 to 3·36, and finds the oxygen ratios of the protoxyds, peroxyds and silica to be nearly as 1 : 2 : 3, often however with an excess of silica. The ratios of his analyses vary between the limits 1 : 1·94—2·16 : 2·95—3·36.—(*Berlin Acad. Ber.* 1856, 605).

If we follow Rammelsberg, who has regarded the small amount of iron in the zoisites, as peroxyd replacing alumina, we have for the analysis VI the ratios 7·62 : 14·73 : 23·25 = 1 : 1·93 : 3·05, while for VII we have 7·21 : 12·93 : 25·65, showing an excess both of silica and protoxyd, due to the intermingled talc. If we regard this surplus of protoxyd as magnesia it would equal 5·70 per cent of talc, and deducting the elements of this from the analysis, we have for the oxygen ratios of the saussurite the numbers 1 : 2 : 3·29. Saussurite has then the hardness, specific gravity and chemical composition of a lime-alumina epidote or zoisite, containing small portions of magnesia and soda, which are frequently present in this species. The analyses of

various epidotes give from two to six per cent of magnesia, and from one to more than two per cent of soda.*—(See *Dana's Mineralogy*, 4th Ed., ii, 407).

6. The composition of zoisite as already noticed by Rammelsberg is identical with that of meionite, a species which is shown by its hardness of 6·0 and its density of 2·6—2·7, to belong to the dimetric division of the feldspar group, where it is to the scapolites what anorthite (with the ratios 1 : 3 : 4,) is to the triclinic feldspars. The mineral described by Boulanger as saussurite from Mt. Genèvre, with a density of 2·65, gives according to his analysis (III) the oxygen ratios 7·37 : 14·18 : 23·75=1 : 1·91 : 2·22, and appears to have been meionite. In de Saussure's analysis, (II) if we regard the iron as protoxyd, we obtain the ratios 5·22 : 14·02 : 28·50, but there is then a deficiency of 4·50 p. c. in the analysis of an anhydrous mineral. Klaproth's results (I) seem to indicate a mixture of a silicate like pyroxene or talc as in VII, while the anomalous softness of V and the facility with which it is decomposed by acids, render it difficult to form any conclusion about the saussurite of the Fiumalto examined by Boulanger. His analysis of the saussurite of Orezza (IV) gives the oxygen ratios 7·23 : 14·95 : 23·25=1 : 2·06 : 3·21, so that it has the composition of meionite and zoisite, while its specific gravity is between the two. Although inferior in hardness, it resembles zoisite in resisting according to Boulanger the action of concentrated sulphuric acid.

The saussurite of Orezza evidently demands farther study; it remains to be seen whether the *verde di Corsica* or *verde antico di Orezza*, as it is also named, (the corsilite of Pinkerton, *Petralogy*, ii, 78), which is regarded by d'Halloy as the typical euphotide, is not distinct from that of Mt. Rose. Delesse found the specific gravity of the Corsican euphotide to be only 3·10. The name

* Laurent in an essay on the silicates published in 1849, insisted that distinctions based on the relations between the proportions of protoxyds and sesquioxyds are of but secondary importance, since these oxyds may replace each other to an indefinite extent in many silicates, without altering the mineral type. This principle Laurent then illustrated by the epidotes among other species, showing from Hermann's analyses of thirteen specimens (of which the analyst had made three sub-species,) that although the oxygen ratios of the protoxyds and sesquioxyds offered considerable variations, it was possible by admitting the substitution of the one for the other, to reduce all these epidotes to the same formula with garnet, SiO_2R_2, *i. e.*, SiO+RO, in which RO, represents both protoxyds like CaO, and sesquioxyds like alO (=$Al_2O_3 \div 3$).—(*Comptes Rendus der Travaux de Chemie*, 1849, p. 277).

This idea of Laurent although at the time rejected, is now universally admitted Dana has adopted it in the 4th Ed. of his Mineralogy; Hermann has recently reviewed his own analyses and accepts Laurent's view, while Rammelsberg who illustrated it in his laborious researches on the tourmalines, has recently applied it to the augites and hornblendes containing peroxyd of iron. But while there is no doubt of the general and wide application of this principle of the homœmorphism of protoxyds with sesquioxyds, it is nevertheless true as Dana has remarked, that in the epidotes the variations in the oxygen ratios of the protoxyds, sesquioxyds and silica are about 1 : 2 : 3, which may be looked upon as the normal ratio for epidote, as 1 : 1 : 2 is for garnet, and 3 : 2 : 5, for idocrase.—(This Jour., [2,] xxv, 406).

of *verde di Corsica*, which in the arts is applied to the rock as a whole, is by Beudant restricted to the contained smaragdite.

I have lately examined a pale yellowish-green compact and apparently homogeneous rock, which forms great beds among the crystalline schists of the Shickshock mountains in Gaspé, and has somewhat the aspect of saussurite. Its hardness is 7·0 and its density 3·04—3·09. It is exceedingly tough and sonorous, has a conchoidal fracture with a feeble waxy lustre, and is translucent on the edges. The analysis gave as follows:

		Oxygen.
Silica	62·60	33·38
Alumina,	12·30	5·78
Protoxyd of iron,	9·40	2·82
Lime,	14·10	4·03
Magnesia,	·72	·29
Soda with a trace of potash,	·43	·11
Loss on ignition,	·16	
	99·71	

The oxygen of the protoxyds and peroxyds in the above analysis equals 4·43 and 8·60. If to these we add the silica corresponding to 13·00 of oxygen, we shall have 61·33 parts of epidote, leaving 32·22 parts of silica uncombined. The density of the mass is that of a mixture of epidote and quartz in the above proportions, and in some specimens where the rock becomes granular, the two species are easily distinguishable. (*Geol. Survey of Canada*, *Report*, 1858). This epidote rock then is completely distinct from the saussurite of Orezza.

The two silicates zoisite and meionite offer a remarkable instance of that isomerism in mineral species upon whose importance I have long insisted. The relation of the specific gravity to the empirical equivalent weights of minerals, must enter as an essential element into a classification which shall unite the chemical and natural-historical systems. Similar isomeric relations exist between kyanite and sillimanite, rutile and anatase, and as I have elsewhere endeavored to show, among the carbon-spars. It becomes necessary in the study of mineral species to determine their relative equivalent weights, to which specific gravity must be the chief guide.—(*Proc. Am. Assoc. Adv. Science*, 1854, pp. 240–247).*

* The action of heat upon organic bodies of high equivalent tends to resolve them into simpler and less dense forms, (we except of course the simultaneous productions of small portions of more complex hydrocarbons). Similar results are obtained when the denser silicates are fused. Thus according to Magnus the specific gravity of garnet is lessened one-fifth by fusion, while that of idocrase is reduced from 3·34 to 2·94. Epidote by ignition has its density changed from 3·40 to 3·20 according to Rammelsberg, and saussurite is converted by fusion into a soft glass of specific gravity 2·8. The silicates thus modified are decomposable by acids like the basic feldspars; idocrase and garnet crystallize after fusion, the latter according to von Kobell in octahedrons. Deville found the density of hornblende and pyroxene to be reduced by fusion from 3·2 to 2·8, orthoclase from 2·56 to 2·35, and labradorite from 2·689 to 2·525.

7. *Smaragdite.*—The smaragdite or diallage of the euphotides appears to have been first examined by Vauquelin, who found in a specimen from Corsica with specific gravity 3·0; silica 50·0, alumina 21·0, lime 13·0, magnesia 6·0, oxyd of iron 5·5, oxyd of chromium 7·5, oxyd of copper 1·5=104·5. (Beudant, *Mineralogie*, ii, p. 134). Boulanger subsequently analyzed the diallage from the euphotide of the Fiumalto already described. It had a density of 3·10, and gave silica 40·8, alumina 12·6, lime 23·0, magnesia 11·2, protoxyd of iron 3·2, protoxyd of manganese 1·4, oxyd of chromium 2·0, water 5·2=99·4.—(*Ann. des Mines*, [3], viii, 159).

I have analyzed the grass-green smaragdite already described as occurring in masses an inch in diameter imbedded in the saussurite VI. It was to some extent penetrated by the latter mineral, and contained irregularly disseminated slender prisms of hornblende, apparently associated with talc. The analysis gave as follows:

Silica,	54·30
Alumina,	4·54
Lime,	13·72
Magnesia,	19·01
Protoxyd of iron,	3·87
Oxyd of chromium,	·61
Oxyd of nickel,	*traces*
Soda,	2·80
Loss by ignition,	·30
	99·15

A partial analysis of another specimen gave alumina 3·80, lime 14·22, magnesia 18·07, protoxyd of iron 2·34. The pale green color of the powdered smaragdite becomes brownish on ignition. The small portion of nickel, whose presence I have already shown in a great number of chromiferous serpentines and diallages,* gave evidence of a trace of cobalt before the blowpipe. The oxygen ratios of the silica, alumina and protoxyds in the above analysis are as 28·96 : 2·12 : 13·29. Its composition is evidently that of a pyroxene, with some admixture of saussurite and probably of talc. A portion of the latter mineral from one of the euphotides of Mt. Rose, was submitted to analysis, and allowing for a small admixture of saussurite, was found to have the composition of ordinary talc, being a hydrated silicate of magnesia with a little iron and a trace of nickel.

Conclusions.—1. The true euphotide is distinct from the diallagic dolerites, with which most modern lithologists have confounded it, and which are composed of pyroxene and a feldspar having the constitution of andesine, labradorite, or a still more basic variety approaching to anorthite. By the substitution of hornblende for pyroxene these dolerites pass into diorite or diabase.

* This Journal, [2,] xxvi, 237.

2. The euphotides of Mt. Rose according to my observations are composed of smaragdite (a pyroxene containing chrome and nickel,) in a base of saussurite, which is a compact zoisite, or lime-alumina epidote, containing portions of magnesia and soda, and having a hardness of 7·0 and a specific gravity of 3·33—3·38; characters which at once distinguish it from the feldspars. These euphotides also contain as accidental minerals, talc, actinolite and occasionally a vitreous cleavable feldspar resembling labradorite.

3. While the minerals analyzed as saussurite by Stromeyer and Delesse are feldspars, that from Mt. Genèvre examined by Boulanger has the composition and specific gravity of meionite, a species which is isomeric with zoisite; the saussurite from Orezza according to the same observer has a like composition but a density intermediate between these species. The saussurite examined by Thompson is apparently a petrosilex.

4. By its great density and its composition, the euphotide of Mt. Rose is related to certain rocks in which a white garnet, resembling saussurite, is mixed with serpentine, with hornblende, and with a feldspathic mineral. These aggregates associated with ophiolites, albitic diorites, and a rock made up of epidote and quartz, occur in the form of beds in the crystalline schists of the altered Silurian series in Canada.*

Art. XXXVIII.—*The Dynamic Theory of the Tides;* by Maj. J. G. Barnard, A.M., Corps of Engineers, U. S. A.

In his treatise on "Tides and Waves," Mr. Airy uses in reference to Laplace's investigation of the tides, the following language:

> "If now, putting from our thoughts the details of the investigation, we consider its general plan and objects, we must allow it to be one of the most splendid works of the greatest mathematician of the past age. To appreciate this, the reader must consider, first, the boldness of the writer who, having a clear understanding of the gross imperfection of the methods of his predecessors, had also the courage deliberately to take up the problem on grounds fundamentally correct, (however it might be limited by suppositions afterwards introduced); secondly, the general difficulty of treating the motions of fluids; thirdly, the peculiar difficulty of treating the motions when the fluids cover an area which is not plane but convex; and, fourthly, the sagacity of perceiving that it was necessary to consider the earth as a revolving body, and the skill of correctly introducing this consideration. The last point alone, in our opinion, gives a greater claim for reputation, than the boasted explanation of the long inequality of Jupiter and Saturn."

* See my *Contributions to the History of Ophiolites,* this Journal, [2], vol. xxv, 217, and xxvi, 234.

The equilibrium-theory, manifestly false in treating the problem simply as one of statics, disregarding the *motions* of the fluid which must accompany the changes of its superficial form, is, at least, an *explanation* of the phenomenon, though not a true theory.

Mr. Airy remarks of it;

* * * * "it must be allowed that it is one of the most contemptible theories that was ever applied to explain a collection of important physical facts. It is entirely false in its principles, and entirely inapplicable in its results. Yet, strange as it may appear, this theory has been of very great use. It has served to show that there are forces in nature following laws which bear a not very distant relation to some of the most conspicuous phenomena of the tides; and, what is far more important, it has given an algebraic form to its own results, divided into separate parts analagous to the parts into which the tidal phenomena may be divided, admitting easily of calculation and of alteration, and thus at once suggesting the mode of separating the tidal movements, and affording numerical results of theory with which they are to be compared. The greatest mathematicians and the most laborious observers of the present age have agreed equally in rejecting the *foundation* of this theory, and comparing all their observations with its *results*. And till theories are perfect (a thing scarcely to be hoped for in any subject, and less in the tides than any other,) this is one of the most important uses of theory."

If we could indeed *grasp* the conditions of the problem—bring into our analysis the expression of the *actual form* (or even a tolerable approximation to that form) of the solid nucleus whose depressions form the ocean beds, then indeed the solution would be that which we seek, not a mere *explanation*, but a true expression for the phenomena, as they actually occur.

While we are utterly incapable of doing this—when such a mind as Laplace's is found unable to grasp the conditions of a "Dynamic Theory," it seems to me that Mr. Airy wastes epithets upon the "equilibrium theory" which, after all, I presume no physicist ever regarded as a *real theory* of the tides, but rather a mere putting into mathematical form of their obvious *immediate* cause. If, to get over the difficulties of the *true theory*, and bring the problem within the grasp of our mathematics, we are obliged to make assumptions, entirely at variance with the facts which really govern the question—which cannot even *approximate* to them—we might as well, so far as the *solution* we seek is concerned, go one step further, and suppose there is no motion at all—or that the fluid is destitute of inertia; in other words fall back upon the equilibrium theory, for the problem is no longer that which we propose, but a mere mathematical study which may yield us some curious results.

"It was found necessary, however, (Airy 'Tides and Waves,") in order to make the application of mathematics practicable, to start with two suppositions, which are inapplicable to the state of the earth. These are: that the earth is covered with water; and that the depth of this water is the same through the whole extent of any parallel of latitude."

If the *actual configuration* of the ocean's bed is, as I have before remarked, the very basis of a dynamic theory of the tides, then a theory which is obliged to reject entirely this actual configuration, and instead of ocean beds of *limited* areas, isolated from each other by dry land in those parallels where the tidal effects are greatest, substitute an imaginary ocean covering the *whole globe*, and of the *same* depth following each parallel of latitude, the problem can be only a mathematical one of more or less interest, from which nothing of any practical value, as to the *actual* phenomena of the tides, can be expected.

Such *is*, in fact, the dynamic theory of Laplace; it has furnished no result nor been of the slightest use to physicists in their investigations of the tidal phenomena. Mr. Airy remarks, "under these suppositions (the arbitrary assumptions as to the ocean's extent and depth) it is evident that the theory is far from being one of practical application;" but when we consider that, in the very effort to make the theory a dynamic one, by introducing the motions of the fluid particles, the *real motions* as governed by the actual configuration of the ocean beds are discarded and purely imaginary ones substituted, we may well hesitate in giving assent to the proposition which finishes the sentence; "though it clearly approaches much nearer to truth than the theory of equilibrium which we have already described."

In the eye of the mere *theorist* it may be so, but to one who seeks a knowledge of the tides as *they actually are*, the equilibrium theory is far more useful; and of two things neither of which possess any claims to be called true, one may be considered as true or the other.

The differential equations which determine the elevation and motion of the water, when the question is limited by these arbitrary assumptions already mentioned, are obtained with no great difficulty. In fact, the equilibrium theory gives the elevation of the water as *it would be* were the water destitute of inertia; in other words, the forces of attraction of the earth and of the disturbing bodies are alone considered, while the forces of inertia in the water itself are disregarded. We have only to introduce *these* forces to convert the equilibrium into a dynamic theory; and thus considering the effects of the fluid motions only in the forces of inertia developed, it follows from the general equations of equilibrium of fluids, that the total fluid pressure resulting will be the sum of the pressures due to the separate existence of each class of forces.

Calling p the total fluid pressure at any point, arising from the action of all the forces, p' the pressure due to the earth's attraction, were its surface undisturbed, p'' the pressure due to the attractions of the disturbing body, p''' the pressure due to the forces of inertia in the fluid, we shall have

$$p = p' + p'' + p'''.$$

If we desire to have the value of p at the *undisturbed surface of the* earth, put $p'=0$ and we have $p=p''+p'''$.

If we call w the height of the fluid column due to the pressure p, and q the height due to p'', we shall have (considering the density as unity) $p=gw$, $p''=gq$, and

$$(1) \qquad gw=gq+p''',$$

in which w is the *total tidal elevation* due to the disturbing attractions, and to the inertia of the fluid, and q is the elevation due to the disturbing attractions alone; in other words, it is the height *due to the equilibrium theory.*

Confining the investigation, for simplicity, to the attractions of the *sun* alone, we shall find from the equilibrium theory (vide Airy's "Tides and Waves" par. 44,)

$$(2) \quad q=S'\left(\frac{P}{P_m}\right)^3\Big[(\tfrac{3}{2}\cos^2\sigma-1)(1-3\sin^2\lambda)+\tfrac{3}{2}\sin 2\lambda\sin 2\sigma\cos(l-s)+ \\ +\tfrac{3}{2}\cos^2\lambda\cos^2\sigma\cos 2(l-s).$$

In which S and σ are the celestial right ascension and declination of the sun; λ and l the terrestrial latitude and longitude of the place, (the latter referred to a meridian *fixed in space*); P the actual and P_m the mean parallax of the sun and S' a coefficient which (vide par. 41 and 42) $=\frac{Sb^2}{2gD^3}\left(\frac{P_m}{P}\right)^3$ (the density of the water being considered insignificant compared to that of the earth) in which S and D are the sun's mass and distance, b the earth's polar radius,* and g the force of terrestrial gravity.

In the equation (2) the angle $(l-s)$ is the difference in *longitude* of the point of observation and the sun, referrred to a meridian *fixed in space.* If we consider the earth a revolving body and call ϖ the longitude of the point, referred to a meridian on the earth's surface, and n the velocity of rotation, then the variable longitude of the point of observation, at the end of the time t, referred to a meridian fixed in space, will be represented by $nt+\varpi$, and the angle $l-s$, by $nt+\varpi-s$.

If instead of the latitude λ we use the *polar distance* θ of the point of observation we shall have

$$\cos\lambda=\sin\theta, \text{ and } \sin 2\lambda=\sin 2\theta.$$

* The *spheroidal* form is disregarded, as the tidal *displacements* are very nearly the same whether the earth is regarded as a sphere or spheroid.

Making the substitutions in equation (2), and then substituting the value of gq in equation (1), we have

$$(3)\quad gw=\frac{Sb^2}{2D^3}(\tfrac{3}{2}\cos^3\sigma-1)(1-3\cos^2\theta)+\frac{3Sb^2}{4D^3}\sin 2\sigma.\sin 2\theta\cos(nt+\varpi-s).$$
$$+\frac{3Sb^2}{4D^3}\cos^2\sigma.\sin^2\theta.\cos 2(nt+\varpi-s)+p'''.$$

If, now, we suppose a particle of water running towards the south and call u the arc (in latitude) passed over at the end of the time t, $b\frac{du}{dt}$ will be the *actual velocity* of the particle, in this direction, and $b\frac{d^2u}{dt^2}$ its acceleration. If θ is the angular polar distance of the initial position of the particle, $b\theta$ will be the actual lineal polar distance, and $\frac{dp'''}{bd\theta}$ will be the differential coefficient of the pressure arising from a variation of θ, and by a slight and admissible extension of the fundamental equations of hydrodynamics we should have $\frac{dp'''}{bd\theta}=-b\,\frac{d^2u}{dt^2}$.

But if the particle has, at the same time, a component of velocity towards the east, represented by $b\sin\theta\frac{dv}{dt}$ (v being arc in longitude moved over in the time t,) its centrifugal force is increased from $\frac{n^2b^2\sin^2\theta}{b\sin\theta}$ (due to the earth's rotation *alone*,) to $\frac{\left(n+\frac{dv}{dt}\right)^2 b^2\sin^2\theta}{b\sin\theta}$, the difference between which is (omitting the term containing the square of $\frac{dv}{dt}$ since it is very small compared to n) $2nb\sin\theta\frac{dv}{dt}$, and the component of this increment, $2nb\sin\theta\cos\theta\frac{dv}{dt}$, will press the particle *towards* the equator and is to be added to the value of $\frac{dp'''}{bd\theta}$ before obtained. Adding it and multiplying by b, we have

$$(4)\quad \frac{dp'''}{d\theta}=-\,b^2\frac{d^2u}{dt^2}+2nb^2\sin\theta\cos\theta\frac{dv}{dt}.$$

Considering now the component of angular velocity to the east $\frac{dv}{dt}$, since the radius of the small circle of latitude in which it

moves is $b \sin\theta$, the actual lineal component of velocity would be $b \sin\theta \frac{dv}{dt}$, while the differential coefficient of the pressure (in space) will be $\frac{dp'''}{b \sin\theta d\varpi}$, and considering this motion *alone*, we should have $\frac{dp'''}{b \sin\theta d\varpi} = - b \sin\theta \frac{d^2 v}{dt^2}$.

But the particle of water has at the same time a southerly component of velocity $b \frac{du}{dt}$.

It is evident that, as it is passing to a lower and larger circle of latitude, to maintain its position in longitude, the moment of its quantity of motion, with reference to the axis of the earth's rotation, will be increased.

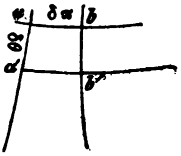
The principle that the moment of the accelerating force is equal to $\frac{d}{dt}$ (the moment of the quantity of motion) (which can be easily deduced from the equations of rotation around a fixed axis—see Bartlett Analyt. Mechanics, par. 229,) will enable us to determine the value of $\frac{dp'''}{d\varpi}$ corresponding to this cause. The accelerating force in this case (or the pressure generated by this motion of the particle) is $\frac{dp'''}{b \sin\theta d\varpi}$, and its moment with reference to the earth's axis is $\frac{dp'''}{d\varpi}$.

The moment of the quantity of motion of the particle of water (per unit of mass) due to the earth's rotation, is $nb^2 \sin^2\theta$, of which the $\frac{d}{dt}$ is $2nb^2 \sin\theta \cos\theta \frac{d\theta}{dt}$. But as the change in the polar distance of the particle is due to the component of velocity $\frac{du}{dt}$, $\frac{d\theta}{dt}$ will be expressed by the same, and hence, from this cause we should have $\frac{dp'''}{d\varpi} = - 2nb^2 \sin\theta \cos\theta \frac{du}{dt}$. (The negative sign is used since the increment of the pressure is in the reverse direction to that of ϖ).

Adding this value to that previously obtained, we have

(5) $$\frac{dp'''}{d\varpi} = - 2nb^2 \sin\theta \cos\theta \frac{du}{dt} - b^2 \sin^2\theta \frac{d^2 v}{dt^2}.$$

Another equation may be obtained from the condition of *continuity* in the fluid.



Let $a a' b' b$ be an elementary area of ocean surface, the angular co-ordinates of a being ϖ and θ, and ab and aa', being equal to $\delta\varpi$ and $\delta\theta$. Let the *depth* of the water at a be γ. According to the assumption with regard to the depth alluded to before, γ varies with the polar distance θ, but not with the longitude ϖ.

Let us suppose the water flowing over this area with angular components $\frac{du}{dt}$ southward and $\frac{dv}{dt}$ eastward; velocities which are themselves variable with θ and ϖ and the time. Taking a space of time t, from the origin of motion, the water will flow past the point a with a velocity which would carry it in that time through the space u, and past the point a', through the space $u+\frac{du}{d\theta}\delta\theta$.

The area of the section ab is $\gamma\delta\varpi$, and of the section $a'b'$, is $(\gamma+\frac{d\gamma}{d\theta}\delta\theta)(1+\cot\theta\,\delta\theta)\delta\varpi$. (Since it is easily seen that the side $a'b'$ is to ab (or $\delta\varpi$) as $\sin(\theta+\delta\theta):\sin\theta$; or as $1+\cot\theta\delta\theta:1$ (nearly). Therefore the quantity of water which flows through the section ab in the short time t, will be $u\gamma\delta\varpi$, and through the section $a'b'$ will be $(u+\frac{du}{d\theta}\delta\theta)(\gamma+\frac{d\gamma}{d\theta}\delta\theta)(1+\cot\theta\,\delta\theta)\delta\varpi$. The *difference* between these quantities, is the quantity of water subtracted from (or added to) the ocean area $a a' b' b$, and is (omitting quantities of the 3d order)

$$\frac{d}{d\theta}(u\gamma)\delta\theta\delta\varpi+u\gamma\cot\theta\,\delta\theta\,\delta\varpi.$$

The *area* of the section $a a' b' b$ is (nearly) $\delta\theta\delta\varpi$ (for convenience, the multiplication by the radius of the earth is omitted with all these angular quantities, as it does not affect the results) and the fall (or rise) of the tide w, due to the southern component of tidal motion, will evidently be equal to the foregoing expression divided by the area $\delta\theta\delta\varpi$.

If we now consider the eastern component of velocity $\frac{dv}{dt}$, the quantity of water which runs eastwardly through the section aa' whose area is $\gamma\delta\theta$ in the time t is $\gamma v\delta\theta$, and the quantity which flows through bb' (since both γ and $\delta\theta$ are constant in this direction) $\gamma(v+\frac{dv}{d\varpi}\delta\varpi)\delta\theta$, and the difference $\gamma\frac{dv}{d\varpi}\delta\theta\delta\varpi$, is the quantity of water subtracted from the area $a a' b' b$ through the eastern component of tidal velocity.—Adding this to the foregoing expression, and dividing by $\delta\theta\delta\varpi$ we get the actual total fall (or rise) of the tide,

$$w = -\frac{d}{d\theta}(u\gamma) - u\gamma \cot\text{an}\,\theta - \gamma\frac{dv}{d\theta} \qquad (6)$$

(The negative sign is used since w represents the elevation, positive or negative, above the undisturbed surface, and if u, and v increase with θ and ϖ, in the preceding discussion, there will be a *fall* of tide.)

Referring back now to equation (3), Mr. Airy has shown (par. 85, 86, "Tides and Waves") that each term multiplied by S may be put under the general form

$$\Theta \cos(it + k\varpi)$$

in which Θ is a function of θ alone: and also that "the equation between w, u, and v; those between p''', u and v; and that between w, p''', and the terms arising from the disturbing force, being all linear, we may take the terms arising from the disturbing force separately, and, finding the solution for each term, we may add all together. It will be sufficient, therefore, to proceed with the solution of the equation" (instead of equation (3))

$$0 = \Theta \cos(it + k\varpi) - gw + p'''$$

and combining this with equations (4), (5) and (6),

$$\frac{dp}{d\theta} = -b^2\frac{d^2u}{dt^2} + 2nb^2 \sin\theta \cos\theta \frac{dv}{dt}$$

$$\frac{dp'''}{d\varpi} = -2nb^2 \sin\theta \cos\theta \frac{du}{dt} - b^2 \sin^2\theta \frac{d^2v}{dt^2}$$

$$w = -\frac{d}{d\theta}(u\gamma) - u\gamma \cot\theta - \gamma\frac{dv}{d\varpi},$$

we have Laplace's differential equations of tidal motions (as given by Mr. Airy).

"A general solution of these equations is scarcely to be hoped for; it is a matter of difficulty to find, in a very limited case, a particular integral which will satisfy them."—(Airy, *Tides and Waves.*") And the particular integral essayed by Laplace and Mr. Airy is of the following form:

$$w = a \cos(it + k\varpi)$$
$$u = b \cos(it + k\varpi)$$
$$v = c \sin(it + k\varpi)$$
$$p''' = a''' \cos(it + k\varpi)$$

in which a, b, c, a''' are functions of θ only.

It is not my purpose to follow the investigation any further, which is purely analytical and consists in determining for each term of equation (3), the values of these quantities, and, thence, of w, u, v, p''', by which we get the elevation, velocity, direction of motion, &c. of the tides arising from the disturbing forces expressed by the particular term.

I will only remark that the compulsory resort to this particular integral *fixes* the original assumption of an ocean covering the whole surface of the globe, irrevocably,—these values of w, u, v, and p''', being simple perturbating functions, whose perturbations in time correspond exactly with those of the forces, while they extend *in space* through the *whole* circumference of the earth, without the possibility of limitation in that direction. In short, it is the particular integral which expresses that *particular tide* belonging to an ocean *continuous in longitude.*

Excepting the arbitrary restriction applied to the variation in *depth*, the differential equations (3), (4), (5) and (6), are perfectly general, and could a general integral be obtained, a limitation of the ocean's area (approximating feebly to the continental barriers) could be established—and, thence, results which might be considered approximations to the actual phenomena. Such an integral, however, is not likely to be obtained, neither Laplace nor Mr. Airy having cared to attempt it.

"As it is, Laplace's theory fails totally in application, from the impossibility of introducing in it the consideration of the boundaries of the sea."

* * * * * * *

"If we look to the results of the theory, it will be found that they are rather of a negative than of a positive kind. They show that, without a far more complete knowledge of the form of the bottom of the sea than we can hope to possess, it will be impossible, even with more powerful mathematics, to calculate tides *à priori.* They show that the calculations founded on the equilibrium-theory cannot be good for anything. In proving that (with sea at least of a certain shallowness) the part of the equator next to the moon would be a place of *low* water, they destroy all hope of using an equilibrium-theory, even as an approximation. In establishing the remarkable result as to the non-existence of diurnal tide in height when the depth is uniform, they show that no inference can be drawn from the mere magnitude of a force as to the magnitude of its effects."—(*Airy*, "*Tides and Waves.*")

It does not seem to me that so difficult and profound a course of analysis was at all necessary to arrive at everything in these negative results at all important.

The remark in the beginning of this paper that "the *actual shape* of the ocean's bottom is the very foundation of a dynamic theory of the tides," seems almost self-evident. But our *mathematics*, thus far, has failed to grasp even the simplest approximation to *shore-outline*,—and if we had the most perfect knowledge of the form of the bottom of the sea, it would be far beyond the powers of analysis to introduce, with any accuracy, its consideration into the problem. Remarks of a similar nature might be made as to the conclusions concerning the equilibrium-theory, which, it seems to me, no philosopher could ever have regarded as *a solution.* Laplace having failed to show what the

effect of the continental barriers is, it cannot be considered as *proved*, that the equilibrium-theory is not as near an "approximation" as anything else we have or are likely to have.

My object in this paper has been to show by what simple considerations and processes the differential equations of Laplace's theory may be arrived at. In doing so I am perfectly well aware that the finding a short path to a *known result* is quite a different affair from the original discovery, and I must also remark that the *considerations* from which equations (4) and (5) are deduced are pointed out (after he has arrived at the equations by long and tedious processes) by Mr. Airy himself.

Mr. Airy concludes his able work on "Tides and Waves," by a "Theory of Waves in Canals," and which, as embracing the subject of the tides, applies to cases such as rivers and arms of the sea, to which neither the equilibrium nor dynamic theory would (if applicable elsewhere) apply,—and to "cases of open seas, where the whole may be conceived divided into parallel canals in which the circumstances are nearly similar."

The "theory" is a very beautiful one and a very valuable contribution to physical science; more valuable, I think however, for its thorough discussion of *waves* in all (or nearly all) the aspects in which they present themselves to the navigator, naval constructor, or engineer, than for its application to the tides. Though it doubtless comes much nearer an approximation to the circumstances under which the tides actually flow in rivers or arms of the sea, than the dynamic or equilibrium theories do to the tides of the ocean, yet the vast difference between the *actual* configuration of shores and beds of such canals, and the simple assumptions the theory is confined to, will probably render this, like all other theories, useless, or nearly so, in practice.

The subject of the tides of the ocean, though perhaps as intelligible as a physical phenomenon, as most others in astronomy, is in its *actual manifestations*, entirely beyond the grasp of our mathematics,—beyond any reasonable conception we can form as to the powers of the human mind to grasp, through any supposed improvement in the means of mathematical analysis. It is probable that, for the aid of the investigator, the "equilibrium theory" has done as much as any theory can be expected to do.

ART. XXXIX.—*On some Fossil Plants of Recent Formations;* by LEO LESQUEREUX.

THE fossil plants of our recent formations have until now attracted little attention. The difficulty of identifying species of dicotyledonous plants from fragments of leaves only, is perhaps the cause of this neglect. Nevertheless the plants of the tertiary and quaternary strata will likely give a solution to some important problems in natural history. Botanists are now intently looking at the flora of those formations, not only to satisfy their minds in regard to the distribution of species of plants in the different strata, but to trace to its farthest limits the history of our present vegetation. They wish to find the origin of some genera and species now living on our earth, to trace their geographical distribution by recording their appearance and destruction at certain places and at a precise time, collecting thus, if possible, some facts that may help to unravel the causes which have changed and may still modify the march of vegetation. It is besides well known and easily understood that plants are more easily influenced by atmospherical changes than animals, at least than testaceous animals, which are those most commonly preserved in the geological strata, these only showing the changes in the sea. Even as characteristic of alluvial or fresh water formations, plants are more reliable than the remains of terrestrial animals, exposed to accidental and unaccountable migrations. The leaf of a palm tree found in the quaternary strata of Northern Russia could never have excited such discussions as did the remains of the elephant found there imbedded in the ice. We may therefore expect to obtain from botanical palæontology more precise indications about the succession of certain geological strata than from shells and animal remains only. This expectation is confirmed by the flora of the different strata of the coal-measures which is evidently different, at least as regards some of the species of plants, for each bed of coal.

Among the collections of fossil plants that have lately come under my examination, the most interesting, by far, is the one made by Dr. John Evans in his U. S. Surveying expedition of Oregon territory, Vancouver Island, &c. A description of these fossil plants appears just now to be a valuable contribution to science, and with the approval of the Secretary of the Interior, I have been advised by Dr. Evans to publish my remarks on those plants in advance of the publication of his report which will contain a full description of the fossil leaves with correct figures.

It will be interesting to mention and compare at the same time some species of fossil plants found by Prof. Jas. M. Safford in

the Pliocene of Tennessee, and some others collected by Dr. D. Dale Owen and myself in the chalk banks or Pleistocene of the Mississippi.

Species of Fossil Plants collected by Dr. John Evans at Nanaimo (Vancouver Island) and at Bellingham bay, Washington Territory.

1. *Populus rhomboidea* (Lsqx.). Leaves rhomboidal, with the margins irregularly toothed above, and entire near the slightly decurrent base. Lateral primary nerves diverging at an acute angle like the secondary ones, and ascending to both corners of the rhomb of the leaf, all strongly marked with scarcely visible percurrent veinlets. It is much like *Populus repando-crenata* of Heer, differing only by the leaves somewhat broader and by the undulations and teeth a little deeper. The *Populus mutabilis* with its numerous varieties is a characteristic plant of the upper Molasse or Miocene of Europe, especially found in the upper strata of Oeningen. (Nanaimo).

2. *Salix Islandicus* (Lsqx.). Leaves large, lanceolate, pointed, serrulate, rounded at the base. Secondary nerves in acute angles with the medial nerve, nearly straight and numerous. Subdivisions of the nerves invisible. A willow with very large leaves, apparently identical with *Salix macrophylla* (Heer) of the Miocene of Europe. (Bellingham bay.)

3. *Quercus Benzoin* (Lsqx.). Leaves shining, oval, with undulate and entire margins decurrent on the petiole. Basilar secondary nerves opposite and emerging in an acute angle above the margin and ascending to the third of the length of the leaves. Upper secondary nerves more open and diverging. The kind of nervation of this leaf is peculiar to a few species of oaks, and has also some likeness to that of the genus Benzoin. This species is distantly related to *Quercus Charpentieri* (Heer), common in the Miocene of Switzerland. (Nanaimo.)

4. *Quercus multinervis* (Lsqx.). Leaves apparently shining and oval like the former; but differing much in the numerous, deeply marked, secondary nerves all parallel, emerging in an obtuse angle from the medial nerve, and slightly arched. It is related to *Quercus neriifolia* (Braun), a species plentifully found at Oeningen. (Nanaimo.)

5. *Quercus Evansii* (Lsqx.). Leaves thick, coriaceous, half a foot long or more, elliptical, with wavy and entire margins. Primary and secondary nerves deep and broad, apparently keeled. Secondary nerves oblique, curved along the margin of the leaves. This species has the same form and nervation as *Quercus undulata*, *integrifolia*, *ovalis*, and *platyphylla* of Göppert, all species which may be referred to the same and found in abundance at Shossnitz. The size of our species is twice larger. (Bellingham bay.)

6. *Quercus Gaudini* (Lsqx.). Leaves oval-lanceolate in general outline, narrowed and somewhat decurrent at the base (sometimes rounded), sinuate, dentate above, entire below, pointed. Nerves deeply marked like the former. Apparently a very variable species, which but for the size of the leaves could be referred to the former. Among our living species, its nearest relative is *Quercus densiflora*, a species of California. (Bellingham bay.)

7. *Quercus platinervis* (Lsqx.). A very large leaf, of which fragments only were collected. It is apparently elliptical, thick, with undulate or irregularly sinuate and toothed margins. Primary and secondary nerves broad, deep, flat; secondary nerves oblique and branching above the middle; surface wrinkled by the deep tertiary and perpendicular nearly percurrent veinlets. Related to *Quercus platanoides* (Göpp.) found at Shossnitz. (Nanaimo.)

8. *Planera dubia* (Lsqx.). Leaves short oval, petioled equally serrate on the margins. Secondary nerves simple, close, running to the point of the teeth. This species is so much like *Planera Ungeri* (Braun), which characterizes the European tertiary, that it is not possible to point out a difference. It may be identical. (Bellingham bay.)

9. *Ficus?* An undeterminable species of which the broken base only is marked on the specimen. By its wavy, entire, and irregular base, and its peculiar nervation, it is referable to *Ficus populina* (Heer), of the Lower Miocene of Switzerland. (Nanaimo.)

10. *Cinnamomum Heerii* (Lsqx.). Leaves elliptical or obovate, slightly decurrent at the base on a broad petiole. Lateral nerves ascending to the top? with obsolete divisions. The genus *Cinnamomum* is largely represented in the Miocene of Europe and appears to be equally so in the tertiary strata of our northwestern continent. The species above described is nearly if not perfectly identical with *Cinnamomum Buchii* (Heer), abundant in the Molasse of Lausanne, Switzerland. (Nanaimo.)

Two fruits of the same genus were found among the specimens of Dr. Evans.

11. *Cinnamomum crassipes* (Lsqx.). Leaves very thick, cuneiform, rounded at the base, with entire margins decurrent on a broad petiole or enlarged medial nerve. Nervation acrodrome, viz., the three principal nerves ascending to the top of the leaf from the acute angle of divergence at the base. Veinlets scarcely visible. The specimens collected all show only the inferior part of the leaves, even without the petiole. But the relation of the species with *Cinnamomum Rossmæsleri* (Heer) of the Miocene of Switzerland, is evident enough. (Bellingham bay.)

12. *Persoonia oviformis* (Lsqx.). Leaves oval-coriaceous, shining or smooth; secondary nerves alternate, the basilar one ascending to above the half of the leaf. Veinlets indistinct. The part of a leaf here described might be referred to *Cinnamomum subrotundum* (Heer), a species most extensively distributed in the Miocene of Europe, but for the basilar secondary nerves which are alternate. It belongs beyond doubt to the Proteaceæ and to the genus *Persoonia*, but I do not know of any species to which it is related. (Bellingham bay.)

13. *Diospyros lancifolia* (Lsqx.). Leaves shining, oval, lanciform, taper-pointed at both ends, entire, petioled. Secondary nerves alternate, strongly marked, somewhat arched and in acute angle with the medial nerve. Veinlets obsolete. The species agrees well with *Diospyros brachysepala* (Al. Br.), common at Oeningen. (Bellingham bay.)

14. *Acer trilobatum?* (Al. Br.). Is the most abundant species of the Miocene of Europe, and I refer to it with doubt two specimens on which except the obtuse sinuses and the nervation, the outline of the leaves is not preserved. (Bellingham bay.)

With the above species I must also mention some leaves which could not be well determined for want of good specimens. A *Platanus?* with the same nervation as *Quercus platinervis;* a *Chamærops* agreeing with *Sabal Lemanonis* Brgt., common in the European Miocene, or rather a true characteristic plant of the tertiary; a very fine *Salisburia*, very variable in the outline of its leaves and named *Salisburia polymorpha* (Lsqx.), distantly related to *Salisburia adianthoides* (Ung.), found in the Pliocene of Italy; a small piece of a fern referable to the genus *Lastrea*, all these found at Nanaimo; and further a branch of *Sequoia*, apparently identical with *Sequoia sempervirens* (Endl.), still living in California. It was found on a piece of coarse sandstone at Coosa bay. A species of the same genus, viz., *Sequoia Langsdorfii* (Heer), is very abundant in the Miocene of Europe, and is so near a relative of *S. sempervirens* that M. Heer doubts if it is not the same species.

From the truly magnificent work of Prof. Heer (the Fossil Flora of the Tertiary), we see that the Shossnitz formation which was formerly referred by Prof. Göppert to the Pliocene belongs to the Upper Miocene; and that the fossiliferous strata of Heering in Tyrol and of Sotzka in Dalmatia, placed by M. Unger in the Eocene, must be admitted as Lower Miocene. Therefore, except the *Salisburia*, which would perhaps indicate a newer formation by its analogy with a species of the same genus found in the quaternary of Italy, there is not in Dr. Evans's collection a single plant that does not show a near relation to some species of the Miocene of Europe. The geological position of the coal strata of Vancouver and of Oregon where the leaves have been found is thus evident. This conclusion is not new; but it is worth remarking how closely the fossil plants characterizing the formation in Europe are analogous to those of North America.

On the coal itself, in connection with these leaves, Dr. Evans has given the following remarks already published in the National Intelligencer. "These coals do not belong to the true coal measures but to the tertiary period; they have however been altered by volcanic action. The Bellingham bay coal particularly, in consequence, is of a remarkable crystalline structure and presents under the magnifier a very singular and beautiful appearance. It will produce an excellent coke, and is well suited to manufacturing and domestic purposes. It burns freely and although rather light for long sea voyages, unless the construction of furnaces should be changed, lessening the draft, is suitable for river navigation. The coal crops out at various points from the British line to near Port Oxford in Oregon, and is accessible to sail and steam navigation, and almost inexhaustible in quantity. These coals with imperfect machines and fa-

cilities for mining can be delivered ready for shipment at from $2 to $3 per ton.

"The average analysis of many specimens gives the following results:

Fitzugh's Mine, Bellingham Bay.

Specific gravity,	1·346	
Carbon in coke,		60·23
Volatile gases,		26·85
Moisture,		10·51
Ashes,		1·94
Sulphur,		·47
		100·00

Bigelow's Mine, Dwamish R.

Specific gravity,	13·78	
Fixed carbon in coke,		54·01
Ashes,		9·00
Volatile gases,		26·33
Moisture,		10·66
		100·00

Coosa Bay.

Specific gravity,	13·84	
Carbon in coke,		59·30
Volatile gases,		25·50
Moisture,		9·50
Ashes,		5·70
		100·00

Species of Fossil Plants collected near Sommerville, Fayette Co., Tenn., by Prof. J. M. SAFFORD, State Geologist of Tennessee.

The species of this collection that are referable to plants of our time are only four.

1. *Laurus Caroliniensis* Mchx. (Red-bay). Grows now in the swamps from South Delaware and South Virginia to the two Floridas, in pine barrens.

2. *Prunus Caroliniana* (Michx.). Wild orange tree; a species now confined to the islands and near the coasts of Carolina, Georgia, &c., and in the Bahama Islands where it is at its true latitude. Michaux remarks that this species is not found on the main land at a distance of two to ten miles from the shores where the temperature is five to six degrees colder in the winter and proportionally milder in the summer.

3. *Quercus myrtifolia* (Willd.). Inhabits now the islands south of Georgia and along the coasts of Florida.

4. Fruit of *Fragus ferruginea* (Michx.). Red beech. This fruit is somewhat more distinctly ribbed on the sides and margins than in our common species, but the characters are not distinct enough to permit a separation of species. The range of the American beech is rather northern. It is found to the south along the Alleghany mountains.

The following plants of Prof. Safford's collection are either new, viz., extinct or undescribed species, or unknown to me.

1. *Salix densinervis* (Lsqx.). Leaves narrow, one and a half to two inches long, lanceolate or tapering at both ends, entire. Medial nerve inflated at the base. Secondary nerves very close, anastomosing as in the leaves of a fern or of a *Trifolium*. The nervation is quite peculiar for a *Salix*, and perhaps when better specimens are found, the plant may be referred to another genus.

2. *Quercus! crassinervis?* (Ung.). The specimen is broken and shows only the middle part of a large, sharply dentate leaf, apparently oval-lanceolate in outline. The *broad nerves* and secondary nerves running to the point of the teeth as the form of the acute teeth also would refer this species to *Quercus crassinervis* Ung., a species found in the Upper Miocene only.

3. *Quercus Saffordii* (Lsqx.). Leaves nearly linear, less than one inch broad, five to six inches long, gradually tapering to a point. Margins regularly and distinctly mucronately serrate, entire near the base and decurrent in a broad petiole or enlarged nerve. Medial nerve broad and flat; secondary nerves oblique, straight, running to the point of the teeth and alternating with short and slender ones. There is not any published fossil species that might be compared with this. It is distantly related to living species of southern Texas and Mexico, but among the leaves kindly furnished to me for comparisom by Dr. Asa Gray, there were none of these new species to which it could be referred.

4. *Andromeda dubia* (Lsqx.). A thick, smooth, elliptical, obtusely pointed leaf, with entire, wavy, and somewhat reflexed margins and obsolete nervation. It is nearly related to *Andromeda ferruginea* (Michx.) of the pine barrens of the south. This near relation would indicate that the true identical species might be found on the islands or along the shores of the Southern States.

5. *Andromeda vaccinifoliæ affinis.* Thick, oval, lanceolate, pointed or obtuse leaves with perfectly the same size, outline and nervation as the above mentioned *A. vaccinifolia* Heer. Its nearest living relative in America is, I think, *Andromeda acuminata.* But the leaves of the fossil species are smaller and the nervation somewhat different. *A. vaccinifolia* belongs to the Upper Miocene.

6. *Elæagnus inæqualis* (Lsqx.). Leaf long, elliptical, obtuse, with entire margins, rounded near the base on one side, and about one inch longer and decurrent on the other side of the short petiole. Secondary nerves well marked, thick near their base, emerging in acute angle, with a camptodrome much divided nervation. I do not know of any living species to which this could be compared. Among the fossil plants its nearest relative is *Elæagnus acuminatus* (Web.) found at Oeningen.

Fossil Leaves collected in the chalky banks of the Mississippi River near Columbus, Ky., by Dr. D. DALE OWEN and L. LESQUEREUX.

1. *Quercus virens* (Michx.). Live oak. The leaves of this species are abundant in the strata. On this oak Michaux remarks that its range of habitat does not extend to more than ten to fifteen miles from the shores of the sea in the Southern States.

2. *Castanea nana?* (Muhl.). Our leaf is somewhat narrower than generally found in this species, which now inhabits the pine barrens of the south.

3. *Ulmus alata?* (Michx.). This species is also mentioned with some doubt. Our leaf is more pointed and its teeth shorter. It might be only a variety of *Ulmus Americana*. The only specimen is deficient.

With the above species there is another *Ulmus!* scarcely one inch long, ovate, with nervation and form of teeth of the genus, which exactly resembles *Ulmus minuta* (Göpp.) of the Upper Miocene. Perhaps it may be a variety of the following species. But it differs evidently in its simple teeth and the rounded base of the leaves.

4. *Planera Gmelini* (Michx.). This species grows now in the river swamps of Louisiana.

5. *Prinos integrifolia* (Ell.). Two leaves of this species were found in the chalk banks. They agree in every point with the *Prinos* still living in Florida.

6. *Ceanothus! Americanus?* (L.). To this very variable and common species, I refer with some doubt two leaves, one large, regularly ovate-obtuse, with somewhat decurrent margins, the other oval-lanceolate, with rounded base. The nervation and serrature of the leaves are just alike and agree with *C. americanus*.

7. *Carya olivæformis* (Nutt.). Pecan. Fruit and leaves in specimens. The geographical habitat of this species is still the same as of old.

8. *Gleditschia triacanthos* (L.). A few detached leaflets evidently belonging to the Locust.

9. *Acorus calamus* (L.). Part of a broken leaf.

10. Some undeterminable catkins of *Alnus* or *Betula*.

The remarks of Prof. D. Dale Owen in the first volume of the Survey of Kentucky, p. 22, indicates the position of the strata bearing these fossil leaves as being about 120 feet lower than the ferruginous sand in which the bones of the *Megalonyx Jeffersonii* were found. The exact position of the strata near Sommerville has not been exactly determined by Prof. Safford. But from the species of plants of his collection, they are referable to the lower or middle Pliocene.

If we now examine the general distribution of the plants enumerated above, we are at once struck with the remarkable character of the Miocenic flora of Oregon and Vancouver Island which evidently indicates a tropical climate at this period of the geological formations. Palm trees, figs, Cinnamomum, and Proteineæ are now generally distributed at least 30° lower than they were then. But it is still more extraordinary to find just on the same latitude but on an opposite point of the globe, in Switzerland, a contemporaneous fossil flora of which the species have so near a relation to those of Oregon that some of them may be regarded as truly identical. This shows a remarkable uniformity in the direction of the isothermal lines at the epoch of the Miocene formation, and establishes beyond a doubt that

the oscillations of temperature have been generally marked around our globe and have not been the result of local geological disturbances. That the oscillations were slow and progressive is shown by the distribution of the species of plants in both the following formations. In the Miocene of Vancouver the Proteineæ are dominant. It has also palm trees and Salisburia, all tropical plants, and most of the species are without relation to the plants now living on this continent. In the Pliocene of Tennessee the Proteineæ appear still abundant and the flora finds its relatives in the southern shores of Florida and on the islands of the Gulf of Mexico. The Post-pliocene of the Mississippi near the mouth of the Ohio river, and even above it, has the same species of plants as are now found along the shores of the Atlantic, in the southern states. We have thus apparently a steady decrease in the temperature from the Miocene to the Post-pliocene of the Mississippi. From this it appears to follow that the chalky banks of which the true geological position is still uncertain, ought to be regarded as anterior in origin to the Drift. For it is probable that if they had been deposited after or at the time of the ice period, the distribution of the plants would show a colder climate rather than the climate of our southern shores.

ART. XL.—*On Bornite from Dahlonega, Georgia;* by Dr. C. T. JACKSON.

BORNITE occurs in Field's gold mine, in Dahlonega, Georgia, in a vein of quartz, associated with native gold and some auriferous iron pyrites, in hornblende slate rocks, bordering the Chestertee River.

The mineral is found in thick foliated masses, having a crystalline structure probably hexagonal, though not perfectly defined. The masses are from half an inch to one inch in diameter, and they split like talc and mica into thin plates, quite as readily as talc.

Its lustre and color, are like those of highly polished steel. It is flexible, sectile, and soils the fingers like plumbago or molybdenite. Its streak on porcelain is metallic, or near the color of the pulverized mineral. Hardness between that of gypsum and calcareous spar, but nearer to the former, say H. = 2·25. Density 7·868. Before the blowpipe on charcoal melts, giving out white fumes, which have the odor of selenium, leaves a white deposit on the cold charcoal, and near the bead a ring of yellow color, and a little metallic bismuth is obtained.

This, cupelled, gives a little gold. In an open glass tube no smell of sulphur observed; a white smoke fills the tube, and condenses in it. Heated, this deposit forms little yellowish globules. At the lower extremity of the tube, a fused metallic mass remains adherent to the glass. A little brown sublimate is mixed with the sublimed telluric acid, and is selenium.

One gram of this mineral selected with care, to avoid all admixture of pyrites, was analyzed and the following results were obtained:

Bismuth, (BO.0·88)	0·7908
Tellurium, (metallic)	0·1800
Selenium, ($BaO+SeO^3$ 0·042)	0·0118
Gold, (mechanically mixed in fine scales)	0·0060
Loss,	0·0114
	1·0000

The bismuth was separated from the nitric solution by carbonate of ammonia, and was several times redissolved and precipitated anew, to free it from all traces of telluric acid. It was then converted by heat, in a porcelain crucible, into oxyd of bismuth. The whole of the washings and the filtrate, mixed, was evaporated to small bulk, and the nitric acid was decomposed and removed by repeated additions of chlorhydric acid and heat until no more chlorine was given off. Then the solution was brought to near neutrality by ammonia and a current of sulphurous acid gas was passed through it, until all the tellurium appeared to be reduced. It was then filtered and washed with water saturated with sulphurous acid, and the filter which had been properly tared was weighed, when dry, at 212° F.

On addition of a solution of sulphite of ammonia to the filtered solution, and allowing it to stand for forty-eight hours, more metallic tellurium subsided, and was collected in a tared filter and the amount was added to that first obtained. Standing twelve hours longer this solution gives no more deposit, though it smells strongly of sulphurous acid gas.

The selenium was determined on a separate sample, of one gram of the Bornite, by converting the selenium into selenic acid, by prolonged digestion in nitro-muriatic acid. Then the selenic acid was precipitated by nitrate of baryta, as seleniate of baryta. It weighed 0·042 gram.

By separate experiments, it was ascertained that no sulphuric acid existed in the solution of the Bornite; hence no sulphur was present.

Boston, March 12, 1859.

ART. XLI.—*Geographical Notices.* No. VII.

PHYSIOGRAPHY OF THE ISTHMUS OF CHOCÓ, NEW GRANADA. By ARTHUR SCHOTT.*—The transit line across the Isthmus of Chocó, New Granada, has been lately re-surveyed, from ocean to ocean, in the neighborhood of the seventh parallel of north latitude, by a party acting under the authority of the U. S. government. The following facts were collected in connection with the field work of the topographical party, under the immediate orders of Lieut. N. Michler, U. S. Topog. Engineers, coöperating officer of the expedition. A more general account of the results of the survey was given in this Journal, November, 1858.

The entire length of the route surveyed is about 160 miles, belonging entirely to the torrid zone, as its greatest elevation does not exceed 1000 feet above the level of the sea. By its physical features this line is divided into two distinct portions, differing from each other both in extent and in meteorological condition. The western or Pacific slope, being only 15 miles long, has an almost constantly dry climate, which appears to be peculiar to the whole extent of the Pacific coast. The eastern or Atlantic slope, 147 miles in length, situated under a sky perpetually clouded, is drenched for eight or nine months of the year by daily rain, more or less heavy. Its atmosphere at the same time is kept in a state of perpetual oscillation by never-ceasing electric changes. Along this portion of the line, the features of the country are decidedly aquatic, varying according to the hypsometrical subdivisions.

From the level of the salt water in the Gulf of Urabá to its marshy uplands and scarcely ventilated mountain forests, every kind of "lowland" is represented,—mangroves, lagoons, everglades, forest swamps and ever-shady uplands.

To facilitate a more detailed examination of the country the following synoptical table is submitted: I. Mangroves and tidewater lagoons. II. Atrato levees. III. Everglades and overflow of the Atrato. IV. The palisades. V. The lowland. VI. The tableland. VII. The Cordillera or Divide. VIII. The alluvium. IX. The mangroves. X. The beach (La Playa).

Not only is the Atlantic slope found at first sight to exceed very much in extent the western or Pacific slope (a feature which applies generally to the whole of the continent,) but also each of the topographical subdivisions mentioned is much more developed on the eastern side than on the western. Throughout almost the entire route, the aquatic character already referred to is distinctly marked in its fauna and flora. A more detailed review

* Communicated for this Journal by permission of the U. S. Navy Department.

commencing on the Atlantic shore in the Gulf of Urabá may be added to the table just given.

Section I. *Mangroves and Tidewater Lagoons.*—Among plants we find prevailing here Rhizophoreæ, aquatic Gramineæ, Polygonaceæ, Aroideæ, lacustric Palmaceæ and Musaceæ, all which by habit correspond to amphibious reptiles, to Natatores and Grallatores among the birds or to the cetaceous Manati, and to fluviatic Cavidæ like the Agouti and Lancha (Dasyprocta and Hydrochœrus). As occasional forms of animals we here find the red roaring monkey (Mycetes seniculus), and of birds two forms related to Sturnidæ, which suspend their nests from the branch-tops of the mangroves, thus making them inaccessible to their enemies. To these may be added a genus of Psittacidæ in the shape of the psittaceous Macao. These birds leave their home in the more elevated regions on the eastern shore of the gulf, to follow their daily sport all over the Atrato delta, which in the evening they leave again. Nearly related, anatomically, to the Scansores are the Halcyonidæ, and we may rightfully consider them as icthyophagous climbers. They are represented by three or four distinct species, and form a characteristic type along the whole line.

This section, of an extent of about twelve English miles by way of the river, may be characterized geologically as floating alluvium, which is covered by a low but densely interwoven arboreal vegetation.

Section II. *The Atrato Levees.*—Where the surface of the country rises up to and above high-water mark, plants of more terrestrial habits are added to the former. Thus Leguminosæ with their suborders Cassieæ and Mimoseæ, also Malpighiaceæ, Malvaceæ, Euphorbiaceæ, Apocynaceæ, Margraviaceæ, Lecythidaceæ, Melastomaceæ, Bignoniaceæ, and others, are met with under a most diversified generic display. While these orders are so varied in habit, and the division of Scandentes is a prevailing type, we find a close analogy to them in the members of the fauna inhabiting this ground. Among the reptiles we observe the Iguano and the Basilisc, both of arboreal habits and only occasionally taking to the water. The Quadrumana generically increase. Mycetes Beelzebub and Pithecia leucocephala (the Zambo and the Mono cara blanca) appear with the roaring monkey. Here also the low form of Bradypus finds a safe and solitary retreat. Among the birds, the Scansores, the most appropriate form for this section of country, are represented by almost every variety. The carpophagous Psittacidæ, the entomophagous Picidæ, and the sarco- or at least oö-phagous Ramphastidæ are leading forms, together with the ichthyophagous

Halcyonidæ and the Anhinga which is a Pelicanid of arboreal habit.

Keeping step with the gradual elevation of the country the fauna and flora increase. Musaceæ and Amomaceæ, with their peculiar maximum development of chlorophyllum, may be considered as equivalents of the two herbivorous pachyderms, which seem to feed on them; they are the tapir and the peccari (Danta and Sajino of the natives). Corresponding to them is the Manati, which is said to abound through this section as it does also within the delta.

The section of the Atrato levees in its geological character is, if the expression is admissible, truly amphibious, for during eight or ten months it is thoroughly swamped by the overflow of the Atrato.

The growth of trees upon it is nevertheless very heavy, and the traveller here meets those well known mighty leguminous giants in company with mammoth forms of Bombax ceiba, and also with Cedrela, Carolinea or a Tecoma. They maintain a prominent stand upon the banks of the river or arrange themselves there in closed ranks as an impenetrable phalanx.

Here the river flows in solitary grandeur, reflecting from its mighty sheet of water an ocean of light and giving freedom to the aerial currents, which show their effects in the surpassing beauty of a tropical flora. Such is the difference, where light and air have access, that even the plague of mosquitos and the lurking effects of sickly miasms, which have their dominion within the enclosures of the swampy forests, disappear upon the openings of the river.

It is a peculiarity of the Atrato that it forms, throughout its course of nearly sixty miles from the head of its delta up to the mouth of the Sucio and still higher up, but one bed, within which it keeps collected the whole body of water, bordered by vertical banks and having an average depth of over fifty feet.

The Atrato levees are scarcely inhabitable. Even the Indians and few Zambos remain upon them only occasionally for temporary fishing and hunting. The only settlement is found at Sucio, and this is but a mere trading station for the Atrato navigators and a shipping depot for the collected raw material of caoutchouc and ivory-nuts. A few natives only remain in this place to profit by raising plantains, bananas and other fruits, Indian corn, calabassas and cacao, which latter prospers here and is of superior quality.

Section III. *The Everglades.*—In leaving the Atrato levees through the mouth of the Truandó a relapse of level is reached, which leads for about 18 or 19 miles through a region of everglades. They form on both sides of the Atrato the recipients

of the river's annual overflow. Here forest-vegetation is almost entirely checked by the eddying currents of the main river and its tributaries. Only certain swells of the bottom or levees bordering on running streams are indicated by the growth of larger trees, and so we recognize here those vegetable cause-ways called caños or calles by the natives, or regular hummocks in the shape of small bushy islands, which stud this vast grassy ocean.

This region is preëminently aquatic and characterized as such by its animal and vegetable forms, among which the "waders" prevail. The trees wear the same mournful adornments as the cypresses do in the dismal swamps of Louisiana or the Carolinas. Long flakes of Tillandsia usneoides are suspended from the tree-tops, playing in the wind like nature's funeral streamers. In many of the trees life seems to be extinct, and a host of para-sites and pseudo-parasitic heirs have taken possession of their leafless branches and withering trunks. Here we find a variety of dendricolous Filices, Musci, Jungermanniaceæ, Hepaticæ, Lichenes, Bromeliaceæ, Aroideæ, and Orchidaceæ.

Numerically the most prominent vegetable forms are a Poly-gonum and a Panicum (the Gramalote and the Tabaquillo of the natives). They are frequently interspersed with a conspicuous arborescent Aroid (perhaps the poisonous Caladium arboreum) in company with which they often stand in from three to ten feet of water. The margin of such growth appears frequently lined with patches of Pontederia azurea (perhaps crassipes?) and the graceful floating Desmanthus lacustris, the Dormidera or sensi-tiva Nadadora of the natives. Both the latter forms are of mi-gratory habits, and the traveller on the Atrato often meets them in the form of large floating islands, upon which little herons and the neat Parra Jacanna have their sport after insects and waterworms.

Corresponding to the dense herbaceous cover of the everglades in which millions of ichthyophagous alligators are found, is the generic and numeric display of wading birds. Among them the most prominent for its size is the herbivorous Cabrilla of the natives (Palamedea chavarilla). Scansores are also fully repre-sented, and also some Conirostres of which the most interesting are a Crotophaga, a Cassicus (cristatus?) and a Tanagra. Of mammals only Mycetes seniculus was noticed.

The everglades are uninhabited, and from their nature will necessarily remain so.

Section IV. *The Palisades* (*Las palizadas*).—If we consider the everglades as a fresh water repetition of the tide-water lagoons below, the section of the so-called palisades may be looked at as corresponding to the Atrato levees only with this difference, that

they are not traversed by a wide running stream like the Atrato but by a multitude of minor rivers and bayous, from which air and light are more or less excluded by the over-lapping branches of the great forest covering it. Consequently we here meet a marked generical decrease of organic forms, when compared with the vegetation upon the banks of the Atrato.

The palisades thus form a belt of forest swamps, which borders the everglades to the west and covers the eastern limits of the sloping lowlands.

If we do not find here that magnificent display of individual development in organic forms which was noticed upon the Atrato levees, we still find a great increase both in species and number, when compared with the lagoons. Here forms of the most diverse nature are thrown together and flourish in closest contact. The same feature is repeated also in the animal kingdom.

Plants and animals of more terrestrial habits enliven this nocturnal region, where the sun never reaches to the bottom, and where not the slightest breeze penetrates beneath the tree-tops.

For this reason the higher forms of mammals are confined to but few orders, as Felidæ, Quadrumanæ, and Sciuridæ, which are naturally fit for arboreal life, and thus avoid the dark swamps below. A far greater increase was noticed among the feathery tribe, among which we find represented: Accipitres, Conirostres with a considerable variety of Buccidæ, Rasores, Columbidæ, Merulidæ, Tenuirostres, Trochilidæ, Muscicapidæ of every shape and size, Sylphiadæ and Scansores, whilst others as certain Rallidæ and Ardeidæ take leave. Of the Rail family, however, the remarkable "Psophia crepitans" seems to be still retained.

The geological character of this alluvial section is peculiar, for within its limits fallen and drifting timber forms a sort of a skeleton for the more firm though only temporary support of an otherwise incessantly shifting soil. This same timber, however, which causes such "*ground-mooring*" produces on the other hand a great number of obstructions to the navigation upon the "*subsylvatic*" branches of the Truandó river and its affluents. This characteristic of the palisades undoubtedly gave rise to the Spanish vernacular name "las palizadas," which signifies any place naturally or artificially defended by fence-work. The name is certain well chosen, for it applies as well to the hydrography as to the topography of the region.

Like Section II, the palisades are scarcely inhabitable, and only a few families of Chocóes (Indians) occasionally build here their temporary lodges, as their hunting and fishing or migrations may require. The cross extent of the palisades amounts to about 14 miles.

Section V. *The Lowland.*—Closely allied to section IV. are the lowlands with an east to west extent of about fifteen miles. The geological physiognomy of this belt differs from that of the palisades only by having a more inclined surface. The upholding strata towards the west end of the section exhibit more or less disturbed, often broken and isolated layers of tertiary rocks.

Nature's means for producing the most surprising results appear often very trifling. Here a slight increase of the angle of inclination changes almost the whole physiognomy of the surface. The Truandó, before divided into endless branches and sweeping like a many-headed Hydra through the nocturnal forests below, now gathers its waters into one bed. Its winding course is bordered by more elevated banks, which are crowned alternately by the growth of heavy timber or densely interwoven brushwork, or appear lined by patches of succulent Endogens of the orders of Musaceæ, Amomaceæ and Gramineæ, whilst the whole seems to be festooned all over with the rich garlands of a perpetual festival.

The general increase of vegetable forms through this section becomes especially marked with Filices, of which nearly all throughout the lower sections have been dendricolous. Now quite a number of forms are noticed to be terricolous within the lowlands. At the same time other orders, as Orchideæ and Aroideæ, decrease in a similar ratio as others increase.

Similar changes take place in regard to animal life. Several species of Rasores and Columbidæ appear in addition to those families observed along the Atrato banks.

Alligators seemed to be lessened in number, probably in consequence of the reduced space, occupied by water. These carnivorous Saurians seem to ascend the rivers of the country to deposit their eggs in the warm sand along the streams, thus securing their offspring above overflow, during the dry season.

The elevation of this section seems to justify somewhat, human habitations within its limits. Thus we find in its western portion one tambo? (station house of the Indians) near the mouth of the Salado, a little tributary of the Truandó. This locality is also oryctognostically marked by a fossiliferous metamorphic limestone? which in all probability will answer the purposes of a first class building stone.

Section VI. *The Table-land.*—At the western margin of the Lowland a rocky terrace rises, the steep side of which faces east. Upon the top of it the table-lands of the upper Truandó and Nercua are placed. The position of the various strata constituting these table-lands are augitic (perhaps trappean) rock, either strongly granular crystalline or compact amygdaloid or

porphyritic in texture, and schistose in structure. Layers of an argillaceous sedimentary rock of little specific gravity, stratified but bearing marks of disturbance, since their original deposition are overlying the former. In the bed of the river, erratic and drifted boulders of concretionary or semi-rock occur. Alluvium uniformly covers the whole. The lower strata are only exposed at the east end of the section and partly along the Truandó. From the mouth of the Nercua upwards only quaternary deposits are standing out.

The upheavings of the metamorphic rocks rise to a height (approximately of from 250 to 300 feet) above the waters of the Truandó; and form here a series of falls and rapids, the river rushing through the narrow pass of this formation for the distance of about three miles.

This catenary mountain range, made up of this rock, seems to be a northeasterly outrunner of the Cordillera to the west, and has received from the surveying party the name "Sierra de los Saltos;" for under the vernacular name "Saltos" this region is known to the natives.

Not only within the enclosures of the mountain pass of the Saltos, but all through the table-lands and their next vicinity below, more distinct potamographical features are perceptible. They consist of a number of real tributaries, each one draining a regular basin of its own. This is quite different from the swampy sections below, the whole extent of which is to be considered as a common estuary, where all the affluents of the Atrato and Truando lose their identity beneath the dead level of a network of lagoons and sloughs.

On the western limits of the table-land interesting signs of a volcanic axis were observed in some thermal springs, one of which was found to have a temperature of 107° F. Here the water is saline and smells like carburetted hydrogen.

On the surface of the table-lands the array of vegetable and animal forms, reaches its highest pitch of development. This undoubtedly is the result of a more thorough ventilation and insolation of the country, in addition to a better regulated drainage, and a diversified sloping of the surface. It is this section only, which a few families of Chocó Indians have taken as a permanent abode, to follow, though constantly roaming, their semi-agricultural pursuits.

Here also the plague of mosquitos and sandgnats ceases gradually; but now the traveller has to guard against the almost imperceptible aggressions of the "nigua" (Pulex penetrans).

Articulata in general appear still more diversified, especially Apidæ, Formicidæ and Cimicidæ, as also a great number of wood-destroying Coleoptera. Xylocolous and troglodytic Arachnidæ, become quite a prominent feature, while the Lepidoptera

and Neuropteræ, the beau monde among insects, display their utmost.

Reptiles also appear in full force with the exception of the alligators, which seem to prefer their sport through more aquatic regions. New forms of fish also appear, as if to exceed the superabundance of the regions below.

Aphidæ have rarely been met with, and only few were collected. The flora is also further enriched by several genera and species of palms, which did not occur below; Areca, Phytelephas, Carludovicea appear strongly represented. A still larger addition however is to be mentioned as regards ferns, which now according to their habitat may be classed as Terricolæ, Saxicolæ, Dendricolæ, and subdivided again into Insedentes, Scandentes, Ripariæ.

It will be observed that no mention has been made of the higher orders of Vertebrata being represented here, though there is no doubt that such is really the case. The scanty means of our travel generally, but especially through this and the following sections, permitted but imperfect observations on this point. One deer was observed however by the majority of the party, and so a member of the Ruminantia, (one of the most interesting orders and apparently rare throughout,) came to be noticed. As the table-lands are inhabited by hunting Indians, the representatives of higher animals, must necessarily be limited.

The line of travel through this section, amounted to about 30 miles.

Section VII. *The dividing ridge.*—The dense and unbroken forests covering this low sierra or cordillera, as some call it, are characterized by a numeric prevalence of palms and quite a selection of "Filices" not seen before. Among the latter several so-called flowering ferns appear. Otherwise a marked decline as well in generic as also in numerical development of floral forms was observed. This is probably caused by a lessened drainage. The head of the last Atlantic stream, Hingadór, is remarkable for the occurrence of several beautiful examples of an arboreous fern, (probably a Cyathea?) attaining a height of from 25 to 30 feet. A second terrestrial orchid came into notice through this section.

With animal forms the general decrease is still more perceptible, and larger animals do not seem to exist here at all, with the exception of the peccari.

A well beaten Indian path loosely connects the Indians on the Nercua with a Zambo settlement on the Pacific shore, which may also account to some degree for the general scarcity of game.

In its geological features the dividing ridge bears some analogy to the structure of the table-land. A similar trappean rock of a schistose texture, perhaps less compact, underlies a deep quaternary bed. Between both, traces of tertiary layers may be discovered by parties better fitted out for exploring purposes than we were.

In the bed of small streams on both sides, an argillaceous deposit of quite recent origin, and a calcareous conglomerate (nagelfluhe) containing coarse sand cemented together with a mortar-like matrix, were observed covering the metamorphic rock beneath. The alluvium sustaining a dense and heavy forest vegetation, made it very difficult indeed to bring out clearly the geological structure of this section.

Except in the beds of the small streams, rocks were nowhere observed. Nothing of the more solid frame of the dividing ridge was discovered except at the head of the Hingadór falls, and on the other side on the banks of the "Pie de Nercua." On the latter place, rocks in situ were seen nearly related to those on the Truandó falls.

The prevalence of terrestrial plants against aereal and arboreal forms observed through the lower portion of the Atlantic slope may justify the idea of supposing the crest of this dividing ridge to be likewise a water-shed and a meteorological divide between both oceans.

This section, though not uninhabitable, is not populated at all; it looks more like a neutral ground between the quiet Indians and the adventurous Zambos on the other side.

The distance travelled across this section is about 7·5 miles.

Section VIII. *The Alluvium.*—This section forms a narrow belt linking together the western slope of the dividing ridge and the tide-water flats below. There seems to be an increase of atmospheric humidity, which produces vegetable increase again. The generic and numeric animal and vegetable forms lost before are somewhat regained, but the region itself is of too little extent to sustain again that opulence which was observed through the corresponding sections on the Atlantic side. It is true the fauna may have been intruded upon by the population of the seaside near by.

This section also contains a number of clearings (rozas) for the cultivation of tropical field and garden fruits, which indeed is fairly commenced by the Zambos.

The width of this alluvial belt, as it was travelled over, is about three miles.

Section IX. *The Mangroves.*—This section is entirely and almost exclusively rhizophorous, much more so than its equivalent on the Atlantic side. In regard to the individual growth

of this remarkable tree, I have seen nowhere in all my travels mangle columns of such size.

One species of fern within this section descends to the tide-water mark in the same way as another species of apparently the same genus on the Atlantic. These two sea-side ferns thus may be looked at as the alpha and omega of filical growth, holding respectively both termini of the isthmus line.

The fauna rapidly decreases, clearing the scene for only a few orders and families of lower organization.

The travelling line through the mangrove belt amounted to about two miles.

Section X. *The Beach* (La playa of the natives).—This narrow peninsular neck of land is separated from the main by a narrow bay. It is a mere gain from the salt water, made by the free beat of the ocean wave, the maximum rise of which amounts to about fifteen feet.

The formation of an eastern equivalent within the Gulf of Urabá seems to be prevented there by the peculiar stowage of the waters, which hold the gulf shores in a continued state of submersion, where the tidal movements do not change over two feet.

The open beach on the Pacific forms the Peninsula of Paracuchichi, named after one of the three rivers emptying their waters into the ocean in its immediate neighborhood. In fact the seaward tendency of their currents has been the principal agency in the formation and partial detachment of this continental appendix, as we may call this peninsula.

The top of this beach above high-tide mark is crowned by a dense growth of brushwork, sparingly interspersed with single trees of larger size, and outwardly lined by a dense row of magnificent Cocos palms.

The fauna upon this outlying flat is entirely littoral and but poorly represented.

The flora is a motley growth of seashore plants and continental forms. The orders of Apocynaceæ, Bignoniaceæ, Cassicæ, Mimoseæ and Leguminosæ are general, also Passifloraceæ, Solanaceæ, Convolvulaceæ, and Gramineæ have been observed. Among the latter bunches of a graceful Uniola were very conspicuous.

The distance across the bay (bahia ensenada) and the beach is about three quarters of a mile.

Note.—In what has preceded it should be remarked that the measurements are only approximative, having been taken from rough field notes.

Georgetown, D. C., February, 1859.

Lieut. Warren's Preliminary Report of Explorations in Nebraska and Dakota.—Lieut. G. K. Warren, U. S. Topog. Engineer, has prepared and published a preliminary report dated Washington, Nov. 24, 1858, (173 pp. 8vo, Washington, 1859) of his explorations in Nebraska and Dakota. It includes a part of his observations in three expeditions; the first in 1855, when he made a reconnaissance of the Dakota country, especially of the routes between Fort Pierre and Fort Kearney, Fort Kearney and Fort Laramie, hence again to Fort Pierre, and thence to the mouth of the Big Sioux; the second in 1856, when he made a reconnaissance of the Upper Missouri, and of the Yellowstone river as far as the mouth of Powder river; the third in 1857, when under the directions of the Secretary of War, he undertook to determine the best route for continuing the military road between Mendota and the Big Sioux, westward to Fort Laramie and the South Pass, thence to proceed northward and examine the Black Hills, returning by the valley of the Niobrara and making thereof a careful examination. In the last named expedition, the most important of the three, he was accompanied by Messrs. J. H. Snowden and P. M. Engel, as topographers; Dr. F. V. Hayden as geologist; W. P. C. Carrington as meteorologist; Dr. S. Moffet as surgeon; and Lieut. James McMillan as commander of the escort, which consisted of thirty men. The report is divided as follows:

1st. Routes explored, and main incidents affecting the direction and extent.

2d. Physical geography of Nebraska, character of the soil, and resources of the country.

3d. Remarks upon the climate and meteorology.

4th. A description of the principal rivers, and discussion of the merits of different routes. And

5th. An enumeration of the Indian tribes, military posts, and routes for military operations.

It is accompanied by catalogues of the palæontological, mineralogical, botanical, and zoological specimens collected on the explorations, prepared by Dr. F. V. Hayden, so as to show the localities where they were found.

Accompanying the copy of the report which we have received, is a map (referred to in the text as in course of preparation) of all the region occupied by the Dakotas, and the best routes by which to approach and traverse it. In the preparation of this map the materials of other explorers, from those of Lewis and Clark and Long, to those of the Pacific R. R. expeditions, have been employed. It is prepared on a scale of 1 to 1,200,000, and embraces all the country from the 94th to the 106th meridian, between the 38th and 50th parallels. In its northeast corner is the Lake of the Woods, in the southeast Fort Leavenworth, in

the southwest Pike's Peak, and in the northwest the junction of Milk river with the Missouri. A number of rivers are put down on this map which have never yet been explored, except at their mouths; these are the Knife river, Heart river, Cannon Ball river, and Moreau river. But Lieut. Williamson remarks that as the expeditions under his command have gone almost around the section through which they flow, and determined with a great degree of certainty that it is an open prairie, and have gained some knowledge of their lengths and directions from the Indians, they are probably represented with a considerable degree of exactness.

We quote the following general remarks in respect to the physical geography of Nebraska.

"Leaving out of consideration for the present the smaller detached mountain masses, and beginning with the main range of the Rocky mountains, on the 49th parallel, we find their eastern base to have a direction nearly northwest and southeast, and the range crossing the Missouri at 'The Gate of the Mountains.' Continuing southeast, it crosses the Yellowstone near where Captain Clark reached that river in 1806, (latitude 46,) just south of which it forms high, snow-covered peaks. This line of mountains is broken through again by the Big Horn river, and the mountains receive the name of Big Horn mountains. The southeast terminus of the Big Horn mountains sinks into the elevated table land prairie, and the range perhaps reappears again as the Laramie mountains. (South of the latitude of Fort Laramie the line of the eastern front of the mountains is nearly north and south.)

"The Black Hills, whose geographical position we have determined, are the most eastern portion of what has heretofore been considered a part of the great mountain region west of the Mississippi; and it is worthy of note that, if a line be drawn from them to the Little Rocky mountains, on the 48th parallel, which are the most eastern portion in that latitude, this line will be parallel to the line of the main front of the mountains which I have already traced. What is still more significant is, that if a straight line be drawn from the mouth of the Yellowstone to the mouth of the Kansas river, it will also be parallel to the lines before mentioned, and will have about an equal portion of the Missouri on each side of it.

"The line of the east base of the main mountain mass is the highest, of course, of any portion of the plains, and at Raw Hide peak, near Fort Laramie, is about 5,500 feet elevation, as determined by the horizontally stratified tertiary deposits, though owing to great denudation the average height there of this line of the plains will not be so great. The same line, near the 49th parallel, has probably a somewhat less elevation. The lowest line of the plains is that along the Missouri, and its elevation, taken near Bijou Hills, (a point about on the perpendicular to it from Fort Laramie,) is about 2,130 feet, which does not differ materially from its height at the mouth of the Yellowstone. The slope of all this part of the plains (being in a direction perpendicular to the lines of equal elevation) has therefore its line of greatest descent in a northeast direction,

and north of the Niobrara; this is the direction in which a majority of the rivers flow till they join with the Missouri or Yellowstone. To the south of the Niobrara the greatest slope of the plains is to the southeast, towards the Gulf of Mexico, and this is the direction pursued there by nearly all the rivers of the plains. Thus the Niobrara would seem, as it were, to run along a swell or ridge on the surface. The average slope of the plains from the Missouri to the mountains make nowhere an angle with the horizon greater than one-half degree.

"A remarkable feature in regard to this change of slope which occurs in the neighborhood of the course of the Niobrara is the shortness of its tributaries, the surface drainage seeming to be away from and not towards its banks. A result of this is the absence of the amphitheatre-like valley which rivers generally have, and which enable us to look down at the stream often many miles distant. Through the greater portion of the middle half of its course you have scarcely any indication of it as you approach, till within close proximity, and then you look down from the steep bluffs, and catch, at the distance of two hundred to five hundred yards, only here and there a glimpse of the river below, so much is it hidden by the precipitous bluffs which at the bends stand at the water-edge. So strongly was I impressed with the fact that the surface drainage could never have been directed along its course so as to have worn out this channel, that I think a portion of it must have originated in a fissure in the rocks which the waters have since enlarged and made more uniform in size, and which the soft nature of the rock would render easy of accomplishment. It is worthy of remark, in this connection, that the bed of the stream in longitude 102° is four hundred feet higher than that of the White river at the point nearest to this; White river having there cut its way entirely through the tertiary formation, flows along the cretaceous, while the bed of the Niobrara is in the miocene tertiary, the pliocene forming the bluffs. The bed of the Niobrara is also, in two-thirds of its upper course, from three hundred to five hundred feet above the bed of the Platte river at corresponding points at the south.

"In the section of the country through which the Niobrara flows the soil is very sandy, so that what rain or snow falls sinks under the surface, and none is lost by evaporation. This is gradually all poured into the stream by the springs in the ravines, and in this way the river is mainly supplied in seasons of low water, at which times it is one of the largest streams of Nebraska."—pp. 60, 61.

WARREN'S MAP TO ACCOMPANY THE PACIFIC RAILROAD REPORTS.—A map prepared under the direction of the Secretary of War, to accompany the Pacific Railroad Reports has been published on a scale of 1 to 3,000,000, including the country, so far as surveyed, between 26° and 49° N. lat. and 90° and 122° W. long. It is prepared by Lieut. G. K. Warren, U. S. Topog. Eng., acting under the department of Explorations and Surveys, of which Capt. Humphreys is director. In its construction, not only the results of the Pacific R. R. Exploring Expeditions, and those of the Mexican Boundary Commission, but all the earlier investigations, which are reliable, including those of Lewis and

Clarke, 1804–6, Long, 1819–23, and many of a more recent date, have been collated and employed. Although much information is yet wanting in respect to the vast regions thus delineated, the map is an important embodiment of what has been ascertained.

CAPT. HUMPHREYS'S REPORT ON THE PROGRESS OF U. S. EXPLORATIONS AND SURVEYS.—The report of Capt. A. A. Humphreys, of the office of Explorations and Surveys, under the Secretary of War, presented to Congress at its recent session has been recently distributed. In addition to a statement of Lieut. Warren's operations, the following particulars are given.

1. The experiment of sinking artesian wells on the public lands has been prosecuted by Capt. Pope so far as to demonstrate that with any reasonable amount of expenditure, artesian wells on the Llano Estacado, and plains of similar formation and position, are impracticable. A well was sunk to the depth of a one thousand and fifty feet; beyond that depth it could not be carried. Apprehensions are even entertained as to whether the water would flow at the surface, if the boring were carried to the depth originally intended.

2. The field work of the exploration of the Rio Colorado of the West has been completed, and the report and maps are now in preparation. The river was ascended by steamboat to a point nearly 500 miles from its mouth (lat. 36° 06′), beyond which it was impracticable to proceed in boats. The ascent occupied about 70 days, but is said to be practicable in ten or twenty days by steamboats of suitable construction and two feet draft. The head of navigation is 220 miles from the first Mormon settlement in the Great Lake Basin, and 500 from the Great Salt Lake.

3. The explorations recommended for the next season are the examination of the interior of Nebraska, especially the sources of the Yellowstone; the region along the San Juan to its junction with the Rio Colorado of the West, and along the Spanish trail from that river to Abiqui; the route across the Sierra Nevada to Carson's river to ascertain its railroad practicability and the upper Columbia river to ascertain its navigability.

DIETERICI'S ESTIMATE OF THE POPULATION OF THE WORLD.—Prof. C. F. W. Dieterici, Director of the Statistical Bureau of Prussia, presented to the Berlin Academy of Sciences in March, 1858, an estimate of the population of the earth, which is printed in Petermann's Journal for January, 1859, together with two other articles from the same pen, giving corresponding estimates for the different races and religions. Dr. Petermann has accompanied the articles with a map of the world, exhibiting at a glance the comparative density of the population in different parts of the globe. The eminence of Dieterici as a statistician gives peculiar value to these estimates. We quote his results,

remarking that the data upon which they are based are given in the journal above referred to.

1. *Total Population of the Earth.*

	Square miles.*	Inhabitants.	Inhab. to sq. m.*
Europe,	182,571	272,000,000	1490
Asia,	793,964	755,000,000	951
Africa,	543,570	200,000,000	368
America,	750,055	59,000,000	79
Australia,	161,452	2,000,000	12
South Polar lands,	2,288		
In the world,	2,433,900	1,288,000,000	529

2. *Population of the Earth by Races.*

Caucasian,—	Europe,	270,000,000
	Asia,	36,000,000
	Africa,	4,000,000
	America,	58,000,000
	Australia,	1,000,000
		369,000,000
Mongolian,	Asia,	522,000,000
Ethiopian,	Africa,	196,000,000
American,	(The Indians,)	1,000,000
Malay,	Asia & Austr.	200,000,000
		1,288,000,000

Or, in round numbers, we may say that of 1,300,000,000 inhabitants of the globe, 375,000,000 are Caucasian, 528,000,000 Mongolian, 200,000,000 Malay, 196,000,000 African, and 1,000,000 American; or by percentage, 28·85 are Caucasian, 40·61 Mongolian, 15·38 Malay, 15·08 African, and 0·08 American.

3. *Population of the Earth by Religions.*

Christians,	335,000,000	or	25·77 per cent.
Jews,	5,000,000	or	·38 " "
Asiatic religions,	600,000,000	or	46·15 " "
Mahommedans,	160,000,000	or	12·31 " "
Heathen,	200,000,000	or	15·39 " "
	1,300,000,000		

The Christians include

Roman Catholics,	170,000,000	or	50·7 per cent.
Protestants,	89,000,000	or	26·6 "
Greeks,	76,000,000	or	22·7 "

FERNANDO DE COSTA LEAL'S REPORT OF THE EXPEDITION TO THE MOUTH OF THE RIVER CUNENE, SOUTHERN AFRICA. —The accounts already published of Dr. Livingstone's explora-

* These are German square miles, one of which equals sixteen English sq. miles.

tions in Southern Africa, and the earnestness with which this intrepid traveller has engaged in a new expedition, give a peculiar interest to all investigations in that part of the world. Among other inquiries which have long been unsettled, the extent and course of the River Cunene, or Nourse, emptying into the Atlantic Ocean, in lat. 17° 30′ S., now appears to be determined. Pimentel, Chapman, Owen, and others had given concerning it such contradictory accounts, that at one time it was supposed to be a large river furnishing the readiest access to Central Africa, and navigable for the largest ships, and at another it was doubtful whether it even extended to the ocean.

A Portugese expedition, in 1854, undertook to ascertain the truth, proceeding from Mossamedes, a colony on the west coast of Southern Africa, to the mouth of the Nourse, and then ascending the river a considerable distance. In Petermann's Journal (1858, p. 412) an account of this expedition and its results is given from the manuscript just received, of Fernando de Costa Leal. We translate the entire article. It is dated Mossamedes, Nov. 24, 1854, and is as follows.

For a considerable time past mention has frequently been made of the River Cunene, the fertility of its banks, and its mineral wealth; but these communications from the traders of the Desert contained nothing in reference to the mouth of the river, and hence it remained undetermined whether the river was navigable throughout its course.

The mouth of the river is on the west coast and not upon the east, as is erroneously represented on the chart to the 'Investigations of Lopez de Lima into the Statistics of our transmarine Possessions.'

According to the representation of the Bush traders respecting the course of the river, and the account of the Muimbas and Musimbas, tribes living upon the left shore of the Cunene, this river has its source in the land of Nano (which, in the language of the natives, means Highlands), constitutes the boundary between Molomba and Kamba, passes by Canhama, situated on its right bank, and then curves round to the coast, below 17° 51′ south latitude.

With a view of rendering a service to my country, I determined to proceed, in person, to the mouth of the river, in order to convince myself of what degree of importance it might prove to the interests of the commerce with Africa. I accordingly sailed from Mossamedes Bay in the schooner 'Conselho,' on the 3d of November, in company with Messrs. Bernardino da Castro, director of the colony, A. A. de Oliveiro Cavalho, Josè D. Franco, and Antonio R. Franco, who had expressed an earnest desire to accompany me. We sailed southward, and arrived at the northern point of the Great Fish bay on the 8th of Novem-

ber. This bay, 6½ miles in breadth, is bounded on the east by immense sandy plains, and on the west by a peninsula of sand; it affords most convenient shelter to ships of every size, and abounds in fish; great profits would be realized from fisheries here established.

The surrounding region presents no trace of vegetation, save a small plant of the genus *Cactus*, but fresh water can be obtained in the immediate vicinity, and upon the coast towards the south, an area of about 30 miles in extent is thickly strewn with trunks of trees, which have been carried, during the great freshets, from the banks of the Cunene to the ocean, and have been thrown by the waves upon the coast to the north of its mouth.

As we approached the head of the bay, it seemed as though a forest and a large sea lay before us, which gave to the country a charming appearance. This vanished in a few moments, for the mirage had converted the smallest bushes into forest trees, and what appeared to be a sea in which were mirrored the large trees and other lofty objects, proved to be only a sandy plain! We spent November 8th, 9th and 10th in the bay. Our object originally was to proceed to the mouth of the river by sea, but since the exact situation of that point was but little known, and it had been reported that we should find the entrance difficult, as well as be unable to come to a secure anchorage, we determined to prosecute the remainder of the journey on land along the coast.

After the necessary preparations had been made, the entire company, consisting of ten whites and eleven negroes, disembarked, and we proceeded on our journey on foot. The shifting sand and the hot sun made our advance slow and tedious; at 5 o'clock P. M. we pitched our tent on the borders of Esponjas (the swamps). On the morning of the 12th we continued our march southwards, advancing over huge beds of granite, which were intersected by basaltic dikes; on our right were still seen the dunes of sand. Our progress was now rendered more easy, and after having advanced twelve miles, we halted for the night near the coast, although not the smallest trace indicated the proximity of the river. A small supply of water remained, with no expectation of our being able to obtain any in the immediate vicinity. Two persons were sent to some distance into the interior, and directed to dig pits for the purpose of obtaining water, but their efforts were fruitless. In no wise disheartened, firmly resolved to overcome all the difficulties of our march, a few other persons set out with the same object in view. In the evening, at half past 9 o'clock, they returned from their successful expedition, bringing two vessels full of clear and fresh water which they had taken from the river only 4½ miles distant from us.

Filled with joy and anxiously awaiting the break of day, we spent the night, and at 4 o'clock in the morning we struck our tent; at 5½ o'clock we reached the right bank of the Cunene, about 1½ leagues from its mouth. We followed the course of the river from this point to its mouth. Here we found that the mouth is completely closed up by a sand bank, which is overflowed only at times of high tide; at other times the water is lost in the sand. Pimental, in his Descriptions makes the remark, that the current of the river can be traced in the ocean for several miles; he also designates the course to be pursued with a boat on attempting the entrance into the river. I am convinced that this navigator passed at the time of high tide, and regarded this as the usual depth of the stream, hence he failed to remark this circumstance. Had we prosecuted the rest of our journey by sea, we would in all probability have determined very little in reference to the river, from the fact that the sand-bank is very high, and completely connected with the banks of the river at its mouth. This would certainly have been the result unless the latitude of the river had been previously determined with accuracy. Even if we had succeeded in discovering the river, the sea, very rough at this point, would have exposed the boat to great peril.

Near the coast, upon the right bank of the river, vegetation is quite abundant, and we met there with great numbers of deer, antelopes and goats. The sea coast takes a south-southeasterly direction, and affords not the least protection. The stream near the sand-bank is very shallow, too much so even to carry a flat-bottomed boat. The banks are but slightly elevated, formed of sand and pebbles, and covered with some vegetation. On our return to the camp, an elephant presented himself to our view, on the opposite bank, and in spite of the perils from the crocodiles swarming the river, to which our hunters were exposed, they crossed in safety and speedily drove the elephant into the interior.

On the 14th of November we followed up the course of the river on its right bank, observing on both sides of the river large piles of wood and thick trunks of trees similar to those seen upon the sea coast. The banks gradually rose to greater height, the stream grew narrower, but thus far no obstructions in the bed of the river were met with; after a two *hours* march we fell in with high waterfalls. Sand dunes constituting the left bank, and perpendicular masses of granite rock the right bank, compelled us to leave the shore and we only returned to it after a march of 4½ hours. The deep winding valleys which intersected the surface in this region, rendered this portion of our march much more wearisome than the earlier portion of it. Finding it impossible to advance any farther on this day, we re-

turned to the river in order to halt for the night on its banks. We found here an agreeable and picturesque spot, vegetation rather rich, consisting mostly of cedar trees, of a size far inferior to the European cedar. The banks here were less elevated, and afford an easy passage, although large rocks abound in the river; and upon the left bank sand-dunes are still seen. At this point we met with many traces of the elephant, zebra, the deer, the fox, the monkey, and the lion. The direction of the stream is N. ¼ West.

We resumed the march on the following day, with no expectation of replenishing an almost exhausted stock of provisions. We halted at 9½ in the morning, and after disposing of the remainder of our provisions, were on the point of turning back, when very luckily one of our soldiers killed a young elephant that accompanied by its dam had ventured within range of our guns. Soon after we resumed our march. The general appearance of the region through which we were advancing was the same, with this exception, that the vegetation seemed to be more fully developed, and the traces of the various animals, especially the elephant, became more numerous. This led us to believe that farther in the interior, great herds of elephants frequent the banks of the Cunene, which at certain seasons of the year, advance towards the mouth of the river. From the source of the stream to the point which we were able to attain, a distance of about 21 miles, we fell in with eight elephants, which all withdrew into the interior.

Up to this point the Cunene presents no points of any importance; its course is winding, the bed of the river narrow and obstructed by waterfalls, and hence not navigable. For even if these were to be removed, (which is not impossible,) yet the mouth of the river could not be cleared; for the current of the river, removing the sand-dunes on the left bank constantly deposits them near the mouth where the water is shallow and the current not so strong. Whether the Cunene be navigable at any point, we are as little able to say, as at how great a distance the tribes living on its banks kept themselves from us.

We discovered a mountain range of considerable height, running in a direction from north to south; but it was impossible for us to cross this range, since we were in no respect furnished with the necessary means. Our mission being quite a different one and already accomplished, we commenced our journey homeward on the 16th of November, and arrived at the Great Fish Bay on the following morning at 10 o'clock. The extent of our whole journey on foot being about 30 miles.

The result of the expedition is already apparent. Many of the inhabitants of Mossamedes, engaged in the trade of the desert, are preparing themselves for an excursion by land to the

banks of the Cunene. If a friendly intercourse with the people of this region be kept up, the colony will here find a new source of trade and wealth. This would result in leading that nation to carry on a direct trade with Mossamedes, after the example of the people of Gamba, Huilla, Jau, Humputa, Quillengues, Humbe, Kamba, Mulonde, and other places. D. C. G.

Yale College Library, April, 1859.

ART. XLII.—*On a new Sulphid of Copper and Lead;* by FREDERICK FIELD.

IN the 'Mina Grande' near Coquimbo, Chili, there exists a mineral containing sulphur, lead and copper, in certain proportions which render it highly interesting. From the same mine have been obtained the following ores of lead: vanadiate of lead, vanadiate of lead and copper, arseno-phosphate of lead, sulphate of copper and lead, and carbonate and sulphid of lead, besides an intimate mixture of sulphid and sulphate of lead, the former mineral evidently undergoing gradual oxydation.

The double sulphid of copper and lead has the following properties. Sp. gr. 6·10. H. from 2·5 to 3. Massive. When broken, a slight conchoidal fracture, having a deep indigo-blue color, quickly tarnishing on exposure to the atmosphere. Immediately associated with carbonate of lead and carbonate of copper.

The pure mineral is violently acted upon by nitric acid, with the formation of sulphate of lead and liberation of free sulphur. 100 parts yielded—

Copper,	53·63
Lead,	28·25
Sulphur,	17·00
	98·88

corresponding to $3Cu_2S, PbS$, which requires Cu 53·33, Pb 28·88, S 17·77.

The only other simple combination of sulphid of copper and lead with which I am acquainted is the cupro-plumbite of Plattner, (also from Chili,) which is a compound of $Cu_2S, 2PbS$.

I have proposed the name *Alisonite* for this mineral, in honor of R. E. Alison, who has spent many years in developing the mineral wealth of Chili.

Guayacan, Coquimbo, Jan. 29, 1859.

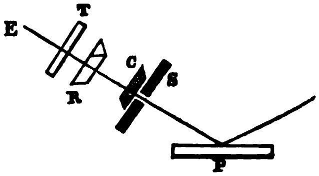
APPENDIX.—In a letter to one of the editors of the same date, Mr. Field observes, that the mineral described by him under the name of *Guayacanite* (this volume, p. 52), he has found to be the rare species Enargite.

ART. XLIII.—*An Abstract of Prof. von Kobell's Stauroscopic Observations;* by OGDEN N. ROOD, Professor of Chemistry in Troy University.

THE following pages contain a brief abstract of Prof. von Kobell's observations with the *stauroscope*, an optical instrument lately invented by him and designed to be used in optico-crystallographical researches.*

In a previous number of this Journal† the instrument was described and figured; the annexed diagram will therefore be sufficient to point out its optical arrangement.

1.



P is a plate of glass which reflects polarized light toward the eye at E, S is the stage-plate or engraved square, C the crystal under investigation, R a plate of calc spar cut at right angles to its optic axis, and T is the analyzing tourmaline. During the experiments the stage-plate S with the crystal is revolved about the axis EP, the rest remains stationary.

I have found it much better to use two Nicol's prisms instead of the glass plate and the tourmaline, and in my own experiments at the end of this article they were employed exclusively.

The plate of calc spar being in its proper position, the tourmaline is turned so as to darken the field, and upon looking through the instrument the usual black cross is seen, of which we shall afterwards speak, surrounded with its concentric colored rings. The dark field which would be seen without the plate of calc spar is more sharply defined by the cross.

When the third cylinder is put in, its slider fitted to the second, and the divided circle turned around to zero, then two sides of the engraved square coincide in position with the axis of the tourmaline. If it be wished to determine the directions (or planes) in which the polarized rays of a double refracting crystal vibrate with regard to the edges of the observed crystal plane, the crystal is to be fastened with wax on the engraved plate over its opening, and turned till one of its sides is parallel with one of the sides of the engraved square, the cylinder with the crystal is then slid in, and the graduated circle turned to 0.

* See von Kobell's "Mineralogie," 2nd edit. 1858, p. 47.
† Vol. xix, 2nd Series, p. 425, and xx, 415.

If the cross is seen unchanged in its position then the polarized rays of the crystal vibrate in the direction of the side of its plane and at right angles to it, but if no cross should appear, or if it should be changed in its position, it is a proof that the rays do not vibrate in the direction of the edge of the crystal plane under observation, and it is necessary to turn the cylinder to which the crystal is attached a certain fixed number of degrees till this happens and the cross again appears in its upright normal position; the angle is read off by means of the vernier. In this manner it is possible to obtain through the stauroscope certain characteristic optical distinctions for the different crystalline systems, by which they often may be determined when other means fail.

I. *System of simply refracting crystals.*

MONOMETRIC SYSTEM.

Monometric crystals show, in every position in which they can be put on the stage, the cross normal; however the stage may be turned it remains unchanged.

Examples: Rock salt, alum, spinel, fluor. Amorphous pieces behave in the same manner.

II. *Systems of doubly refracting crystals.*

All doubly refracting crystals show in certain directions the cross *inclined*, or by revolving them they *extinguish* the normal cross; it is only in the directions of their optic axes that they behave to a certain extent like monometric crystals.

Systems with one optic axis.

1. DIMETRIC SYSTEM.

(1.) Seen through a plane of the quadratic pyramid the cross arranges itself according to the verticals of the triangle or at right angles to each of its sides.

(2.) Through the prismatic faces the cross has the position of the principal axis.

(3.) Through the basal plane the cross appears normal and remains unchanged when the crystal is revolved.

Examples: Apophyllite, idocrase, zircon, scapolite.

2. HEXAGONAL SYSTEM.

(1.) Through a plane of the hexagonal pyramid the cross stands in the directions of the verticals of the triangle or at right angles to each of its sides.

(2.) Through the sides of the rhombohedron the cross arranges itself in the directions of the diagonals.

(3.) Through the faces of the scalenohedron the cross arranges itself according to the lines of altitude of the sides of its holohedral dihexagonal pyramid, or at right angles to the sides of its horizontal twelve-sided transverse section.

(4.) Through all the prismatic sides the cross is seen normal in the direction of the principal axis.

(5.) Through the basal plane the cross is seen normal and unchanged by the revolution of the crystal.

Examples: Apatite, quartz, calcite, chabazite, emerald.

Systems with two optic axes.

In these systems there occur no planes through which the normal cross remains unchanged during the revolution of the crystal.

3. TRIMETRIC SYSTEM.

(1.) Seen through a plane of the rhombic pyramid the cross makes *three* angles with the three sides, corresponding to the inequality of the sides of the triangle.

(2.) Through the prismatic faces and also through the macro- and brachy-diagonal planes the cross is in the direction of the principal axis, also through the domes it is in the direction of the dome edge.

(3.) Through the basal plane when it is rhombic the cross stands in the direction of the *diagonals*, when it is rectangular in the direction of its sides.

By revolving the crystal the cross becomes pale or is altered by colors.

Examples: Heavy spar, topaz, sulphate of magnesia, aragonite, chrysolite.

4. CLINO-RHOMBIC OR MONOCLINIC SYSTEM.

(1.) Through the lateral planes of the oblique rhombic prism the cross is inclined to the principal axis; also through the planes of the clinodome it is inclined to the dome-edge. The angle through which it is necessary to turn is the same for like planes, and the crosses are turned towards or away from the clinodiagonal chief section to the right or left with equal angles, when seen respectively through the back or front sides of the crystal.

(2.) Through the orthodiagonal plane the cross is normal in the direction of the principal axis.

(3.) Through the clinodiagonal plane the cross is inclined to the principal axis.

(4.) Through the basal plane of the rhombic prism the cross stands according to the diagonals.

Examples: Diopside, selenite, orthoclase, epidote, borax.

5. TRICLINIC SYSTEM.

The cross appears through every plane inclined at a certain angle, when any one of the planes or corresponding edges of the crystal is placed horizontal or vertical on the engraved stage.

Examples: Kyanite, albite, sulphate of copper.

ART. XLIV.—*Stauroscopic and other Optical Experiments;* by Prof. OGDEN N. ROOD.—Part I.

1. *Stauroscopic Observations on Cooled Glasses.*

IN the Stauroscopic observations of Prof. von Kobell plates of crystals with natural or artificial parallel sides were employed, and it is of course a matter of indifference through which part of the plate the polarized beam is transmitted, the phenomena observed being the same whether the centre or any of the edges be employed. The case is however different with plates of glass of a definite shape to which double refraction has been communicated by sudden cooling from a red heat or otherwise.

Having arranged a stauroscope with an open stage I submitted to examination pieces of glass of different figures to which double refraction had been thus communicated; the following are some of the *simpler* results obtained.

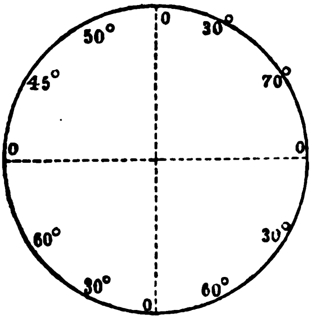
1. Through the centre of the equilateral triangle the cross arranges itself in three positions, at right angles to its three sides; the cross is of course not stationary when the triangular plate is revolved. The same is true when the polarized beam is transmitted through three spaces near the middle of its sides.

Through the angles of the triangle the cross is *inclined* to the above mentioned planes.

I found no spot in the triangle where the cross remained unaltered when the glass plate was revolved.

2. Through the centre of a circular plate of glass the cross remained tolerably unaltered by revolution, this position of the plate corresponds therefore to the basal plane of a crystal belonging to the dimetric system.

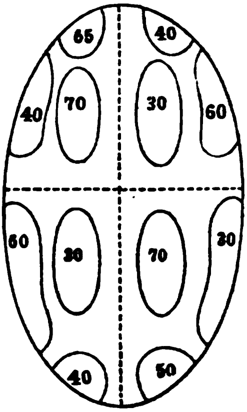
1.



Through the spaces 0, 0, 0, 0, the crosses are altered by revolution and arrange themselves in the positions of the dotted lines. Seen through the spaces marked with figures the crosses arranged themselves at these angles to the dotted lines.

3. Through the centre of an elliptically shaped plate the cross was altered by revolution and arranged itself in the directions of the major and minor axes. The same is true for the spaces along the dotted lines.

2.



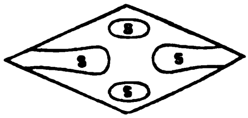
The inclinations of the crosses to the axes of the ellipse in different portions of the plate will at once be seen by the annexed diagram, and also that the arrangement of the outer portions is essentially the same as in the circle, the main difference being in the occurrence of the oval-shaped spaces on either side of the foci.

4. Through the centre of the *square* the cross remains tolerably unchanged by revolution; near the middle of its sides the cross is altered by revolution and arranges itself at right angles to the sides.

In the angles it was inclined to the sides of the square at angles of from 30° to 50°. In a perfectly evenly cooled plate it would probably arrange itself according to the diagonals.

5. Through the centre of a rhombic-shaped plate the cross arranged itself parallel to *only* two sides of the rhomb; it remained always somewhat colored. (See under circular polarized light.) Through the spaces *s, s, s, s,* it arranged itself according to the diagonals.

3.

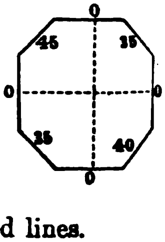


6. Through the centre of a rectangle, whose length was four times its breadth, the cross arranges itself according to the diameters: in the angles the crosses are *inclined* at certain angles to the diameters.

When two pieces of this shape are laid one upon the other, parallel or at right angles, and viewed through their common centre, the cross still arranges itself parallel and at right angles to their sides.

When the plates were inclined 45° to each other no black cross was seen in any position; in its place a red or green nebulous cross appeared at all inclinations. (See below.)

4.



7. Through the centre of an octagonal shaped plate the cross remained tolerably unaltered by revolution; in the spots marked 0 the cross was altered and arranged itself accordingly to the dotted lines; in the spaces marked with numbers the crosses made these angles with the dotted lines.

From these observations it will be seen that the crosses remain unaltered when viewed through the centres of regular polygons, as for example, the square, the octagon, and the circle, the latter being considered a regular polygon with an infinite number of sides; the *centres* of such polygons are therefore uniaxial and correspond to the basal plane of uniaxial crystals: the positions of these solids which I have marked 0 correspond with the *prismatic faces* of uniaxial crystals; the portions marked with numbers correspond in a certain sense with the planes of the quadratic pyramid. It is remarkable that we should have in portions of one plate a representation of the action of all the planes of a *crystal.*

The central portions of the ellipse and rectangle correspond to the basal plane of a crystal belonging to the rhombic system; the rhombic plate of glass had not been cooled with sufficient regularity to base a conclusion on its action though indications were observed which would place it along with the ellipse—at all events the spots marked *s* acted like the rhombic shaped basal plane of a rhombic prism.

The centre of the triangle corresponds in action to a plane of the quadratic pyramid.

2. *Observations on Circular Polarization by means of Cooled Glasses.*

(1.) The celebrated physicist, Dove, found when a *cube* of glass was suddenly cooled and afterwards placed in a polarizing apparatus and inclined 45° to the plane of primitive polarization, that the plane polarized beam was converted into circular polarized light by transmission through the corners of the square plate; this he proposed as an easy method of producing circularly polarized light.

I have found that when a beam of polarized light is transmitted through the centre of a *rhombic* shaped plate of glass (see above) which had been thus treated that the light was more or less circularly polarized *whatever the position* of the rhomb with regard to the plane of primitive polarization might be, though the experiment succeeded more strikingly when its position corresponds to that of Dove's cube. The polarization was right-handed, and the colors were as brilliant and followed each other with as much regularity as when seen through a quartz plate cut expressly for this purpose.

(2.) Through the centre and portions along the major diameter of an elliptically shaped piece of glass the light is also circularly polarized when either of the axes are inclined at angles of 45°, 135°, &c., to the plane of primitive polarization. The polarization was right-handed, and in both these cases a *large beam of circular polarized light* was obtained; by changing the angle of the

plate with the plane of primitive polarization I easily obtained elliptically polarized light, the axes of the ellipse having any desired relation to each other.

(3.) Through the centres and along the chief diameters of rectangular shaped pieces of glass, whose length was four times their breadth, the light was also circularly polarized when the inclination was 45° to the plane of primitive polarization. When two rectangles were crossed at an angle of 45° and placed as above, the light was more completely circularly polarized, it was found to be *right-handed;* upon reversing the inclination of the rectangles to each other the beam was turned to the *left hand.*

It will be seen therefore that by means of two similar rectangles of cooled glass, either right or left-handed circular polarization may be obtained at pleasure, an observation I believe which has never before been made.

(4.) The light in all the angles of the octagon was circularly polarized.

3. *On the appearance presented by circularly polarizing crystals, &c. in the Stauroscope. The cross a means of detecting circular or elliptical polarization.*

If a plate of quartz be cut at right angles to its axis and of such thickness that for example it gives the yellow tint when placed in the field of a polariscope, then when introduced into the stauroscope it will modify in a certain manner the cross and the colored rings.

(1.) No *black* cross will be seen in any position of the quartz plate; in its place a *yellow* cross appears which remains stationary and in its normal position when the quartz is revolved, and the white quadrants next to the calc spar cross are replaced with patches of red and blue color.

(2.) When the analyzing plate is revolved the yellow cross *revolves with it,* passing at the same time through all the prismatic tints, the rings not being greatly changed. If the plate is thicker or thinner than the above mentioned, the initial cross will merely in the first instance be differently tinted, but the color will in every case be the same with that which the whole plate would have if placed in the darkened field of a polariscope; the rest of the phenomenon remains the same. The circular polarized light obtained through cooled glass acted in exactly the same manner.

I have found this colored cross, stationary and revolving, an excellent means of detecting circular polarized light when it would otherwise have been overlooked, that is, when such a brilliantly colored cross is seen which revolves with the analyzer through the whole circle, changing always in tint but never becoming black, it is a proof that the light is *circularly* polarized.

When the polarization is elliptical a colored cross it is true will be seen and it will revolve with the analyzer and change in tint, but at angles of 180° it becomes normal and nearly black.

Of course light occurs in every state of polarization, passing from elliptical through circular to plane, according to the relative dimensions of the axes of the ellipse, but after some practice it is possible by means of the cross to judge of these dimensions approximately.

In examining this matter, besides using plates of quartz, &c., I constructed an apparatus for producing plane, circular, or elliptical polarization by means of the inclinations to the plane of primitive polarization given to a lamina of mica of a certain thickness, the state of polarization of the light from the mica was examined with a doubly refracting rhomb of calc spar before observing the cross.

Troy University, Dec. 25th, 1858.

Art. XLV.—*On Boltonite;* by Prof. Geo. J. Brush.

The identity of this mineral with chrysolite was pointed out by Professor J. Lawrence Smith in this Journal, vol. xviii, p. 372 (November, 1854). Previously to this Dr. Kenngott* endeavored to show from analyses made by v. Hauer that boltonite was a distinct species. Subsequently† Kenngott calls in question Smith's conclusions: from v. Hauer's analyses he draws the formula $\dot{R}^5\dddot{Si}^3$, and insists that this, together with the low hardness (5·5) of the mineral, shows that boltonite is not chrysolite. In Dr. Smith's examination, the mineral was as carefully selected from the gangue as possible and then freed from adhering carbonates by repeated treatment with dilute hydrochloric acid; afterwards great care was taken in choosing for analysis the purest of the fragments thus treated. Three analyses made upon specimens so selected gave:

	$\dddot{Si}$	$\dot{Mg}$	$\dot{Fe}$	$\bar{Al}$	Ignition.
1.	42·56	51·77	2·35	0·10	2·22 = 99·00
2.	41·95	51·64	3·20	0·25	1·58 = 98·62
3.	42·41	50·06	3·59		not. det. ——

which excepting the slight amount of loss by heat (not necessarily water) indicate a perfect correspondence with chrysolite.

Von Hauer did not find it practicable to separate the boltonite from the gangue, but analyzed a specimen with the accompanying gangue. In his first analysis the mineral was decomposed by fusion with carbonate of soda. His results gave—

* Mineralogische Notizen, Zwölfte Folge (March, 1854).

† Uebersicht der Resultate mineralogischer Forschungen im Jahre, 1854. Leipzig, 1856.

	$\ddot{S}i$	$\dot{F}e$	$\dot{C}a$	$\dot{M}g$	$\ddot{C}$
No. 1.	13·32	3·80	29·00	21·17	32·71

The carbonic acid (32·71 per cent) was determined by the loss.

In the second analysis, made upon the same mixture, the mineral was treated with dilute hydrochloric acid, and the bases in the acid solution were determined and *calculated* as carbonates. The insoluble portion was decomposed by fusion with carbonate of soda. The magnesia in both the soluble and insoluble portions were determined *by the loss.* Analysis No. 2 gave—

$\dot{F}e\ddot{C}$	3·37	72·70 soluble in H Cl.
$\dot{C}a\ddot{C}$*	50·93	
$\dot{M}g\ddot{C}$	18·40	
$\ddot{S}i$	12·85	27·30 insoluble in HCl.
$\dot{F}e$	1·74	
$\dot{C}a$	0·94	
$\dot{M}g$	11·77	

Assuming the carbonic acid (which was determined by the loss) in No. 1 to be combined with the bases in the same manner as found in No. 2, Kenngott shows that No. 1 contained 28·64 per cent insoluble in acid. The percentages of the substances in the insoluble portions in both analyses would then be:

	$\ddot{S}i$	$\dot{M}g$	$\dot{F}e$	$\dot{C}a$
1. (a)	46·50	43·89	6·08	3·53
2. (a)	47·07	43·11	6·38	3·44

Kenngott calls attention to the close correspondence between the analyses and insists that the method employed by v. Hauer to obtain the true composition of boltonite is quite as satisfactory as that adopted by Smith.

It is however worthy of remark, that the carbonic acid in both of v. Hauer's analyses was determined by the loss, that the magnesia in both soluble and insoluble portions in No. 2 was also determined by the loss, and that the errors have been increased more than threefold by the manner in which the analyses were calculated. It may well be questioned whether conclusions based upon analyses made in such an indirect manner should be permitted to throw doubts on analyses of carefully selected material where everything was determined directly.

The fundamental point in the conclusions which Kenngott draws from v. Hauer's analyses depends upon the assumption† that boltonite is not attacked by dilute hydrochloric acid, for in

* In the analysis the $\dot{M}g\ddot{C}$ is stated to be 50·93 and $\dot{C}a\ddot{C}$ 18·40, but the remarks that follow show that this inversion is a typographical error.

† To avoid misrepresentation on this important point I quote from the original article, p. 27 of the 12th No. of Kenngott's *Mineralogische Notizen:* "Da aus der Analyse hervorgeht, dass das Grundgestein kein reiner Calcit ist, auch der Einfluss der Luft auf das Grundgestein zeigt, dass es Eisenoxydul enthält, so wurde eine zweite Probe desselben Gemenges mit sehr verdünnter Salzsäure digerirt, wobei das Silicat, der Boltonit, gewiss nicht angegriffen werden konnte."

No. 2 the portion insoluble in dilute hydrochloric acid was considered to be pure boltonite, and from this was calculated the composition of boltonite as given in 1 (*a*) and 2 (*a*).

But I have found by experiment that boltonite is acted* upon even by very dilute hydrochloric acid, and this being the case, the insoluble portion in v. Hauer's analysis must have contained an excess of silica derived from the partial decomposition of boltonite by dilute acid. It is therefore evident that any conclusions in regard to the composition of boltonite based upon the analysis of this insoluble portion must be erroneous. This partial decomposition of boltonite also affords a satisfactory explanation of the excess of silica in v. Hauer's analysis over that obtained by Smith.

It is unnecessary to follow Kenngott farther, as I shall proceed to show from my own analyses the correctness of Smith's conclusions.

In the year 1854 I made an examination of boltonite, but not being entirely satisfied with the purity of the substance analyzed, the analysis was not published. The mineral was separated from the gangue by acetic acid and selected as carefully as possible. Fused with carbonate of soda it gave—

$\dddot{\text{Si}}$	$\dot{\text{Mg}}$	$\dot{\text{Fe}}$	$\dot{\text{Ca}}$	$\bar{\dddot{\text{Al}}}$	Ignition.
40·94	50·54	4·37	1·20	0·27	3·28 = 100·60

Disregarding the ignition, the result confirmed Dr. Smith's analyses, but I could not be certain that the mineral was perfectly pure, and it was not until a few weeks since that Prof. C. U. Shepard kindly placed at my disposal a specimen containing large irregular crystals of boltonite from which I have been able to select the mineral pure for analysis.

It occurs in a magnesian limestone in crystals which are sometimes more than an inch in diameter; these irregular crystals implanted in the gangue often present rectangular sections, and have a very distinct cleavage in one direction. The color of the specimens I examined was dark ash-grey, but small fragments were almost colorless. It scratches feldspar, and therefore the hardness is 6 or a little above. Its specific gravity is 3·21. Before the blowpipe in platinum forceps it does not fuse but the color changes to light-yellow; with salt of phosphorns gives reactions for silica and iron. When treated with very dilute hydrocloric acid (i. e., one part acid to ten parts water) the powdered mineral is partially decomposed. In the quantitative analysis the mineral was first powerfully heated over a blast lamp and subsequently decomposed by carbonate of soda. The analysis gave—

* Dr. Smith also alludes to this fact *loc. cit.*

		Oxygen.		Ratio.
Silica,	42·82	22·25	22·25	1
Magnesia,	54·44	21·77		
Protoxyd of iron,	1·47	·33	22·34	1
Alumina,	*trace.*	——		
Lime,	0·85	·24		
Ignition,	0·76			
	100·34			

This ratio gives the formula of chrysolite $R^2 Si$. The analysis fully confirms Dr. Smith's conclusions, and shows that boltonite is a *magnesian* chrysolite, that is, unlike other varieties of the species, it is a silicate of magnesia and not of magnesia and iron.

Yale Analytical Labratory, Dec. 1st, 1858.

ART. XLVI.—*Varying Level of Lake Ontario;* by Prof. C. DEWEY.

IN vol. xxxiii of this Journal I gave the varying temperature of Lake Ontario in 1837, and confirmed the result by observations in vol. xxxvii. The variations in the level of this lake, as well as of the other great lakes of this chain of waters, has been the subject of much observation and of many singular, if not absurd, traditions and speculations. The want of measures, known to be reliable, has been a great support of these fancies. In the following Table the remedy is in part attained. The measures were made at the Port of Genesee, Charlotte, at the mouth of Genesee River, by order of the Government. They have been reported annually in the local papers, and in the Regents' Report, and I now present the measures and results obtained for the thirteen past years.

Variations of the Level of Lake Ontario, for the enumerated years, measured from a fixed point downwards to the water.—The *larger* the measure, the *lower* the level.

TABLE.—Measure in inches.

Years.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep	Oct.	Nov.	Dec.	Mean.	Range	Relative.
1846	51	54	48	45	42	39	39	42	45	45	48	45	45·2	15	Low.
1847	48	42	36	36	29	25	25	25	36	39	43	46	35·8	23	Bel'w mean.
1848	29	34	43	38	38	37	38	39	44	49	54	53	41·3	25	" "
1849	50	50	52	46	36	33	44	39	45	38	38	41	42·7	19	" "
1850	45	40	40	40	32	29	34	46	47	52	55	43	41·9	26	" "
1851	44	54	48	47	44	38	35	38	42	47	53	51	45·0	19	Low.
1852	50	51	48	44	26	26	22	24	30	23	38	34	34·7	29	Higher.
1853	35	32	32	25	20	14	27	20	24	28	38	39	27·8	25	High.
1854	39	39	38	38	27	24	25	27	36	44	48	50	36·2	26	Bel'w mean.
1855	52	53	36	40	40	36	34	36	36	34	33	33	38·6	20	" "
1856	35	35	33	31	23	18	23	30	37	46	53	53	34·7	35	Higher.
1857	54	56	46	44	35	24	19	12	14	9	24	22	30·0	47	High.
1858	19	13	13	18	4	6	4	2	8	12	14	16	10·9	17	Very high.
Means.	42	42	39	38	30	27	28	29	34	36	41	40	29·8	25	

Some results are obvious on the Table.

1. The summer months have higher water, for 10 of the 13 years. As this depends on the melted snows and spring rains over the greater watershed, the water is higher in the eastern of the lakes later in the season, affecting Lake Ontario after Lake Erie.

2. The winter months have the lower water for ten of the thirteen years. This is owing to the less water which falls over the section in the fall months and the greater evaporation through the preceding months.

The means of the months at the bottom of the table illustrate the general conclusion involved in these two results.

3. In 1848 the level was the lowest in November; in 1850 in November, and in 1856 equally low in November and December, from the less rains in the preceding months.

4. In 1848 the highest was in January; and in 1857 in October; and in 1855 in November, from preceding rains.

5. The lowest measured in these years was in February, 1857, and the highest in August, 1858, giving the range in the whole period to be 56−2=54 inches. [The maximum and minimum level was at Toronto in the same two months of these two years, and the range was the same, 54 inches. For this fact I am indebted to the intelligent and accurate observer at that port in Canada West, the Harbor Master. The range is found to be nearly the same in Lake Michigan.] These facts show that the common statements, in the summer of 1858, of the lake being some feet higher than before known or in many years, were utterly false. In 1858 the level was seven inches higher than in 1857.

6. There is no periodical rise and fall of the lake discernible on the table, and the variations in the level of the lake seem to be dependent on very regular and adequate causes of supply and drain.

7. Observation shows that the direction and force of the winds make the variations not altogether simultaneous at the ports having positions differently affected by the winds. Still a series of observations must lead to closely approximate results.

8. The table contains only the slow monthly and annual changes of the level. I have not introduced other measures, made in some other parts of this lake, on account of the impossibility of reducing them to the same zero, as there has been no standard, but different points have been assumed by observers. Neither have I noticed those sudden changes of the level, where the water falls or rises several feet in a few moments; and when the return wave causes the water to rise or fall alternately three to six feet. These alternations occur several times about twelve or fifteen minutes apart till the water comes to the previous level. Some of these are known to have been caused by violent winds or whirlwind tempests. Probably this is the uniform cause, as it is fully adequate to the effect.

Rochester, N. Y., March, 1859.

Art. XLVII.—*Contributions to Mineralogy*; by F. A. Genth.

1. *Whitneyite, a new species.*

Massive, structure crystalline, finely granular. H. =3·5. Sp. gr. at 16° Cels. =8·408. Lustre metallic; color reddish-white (about that of the new American cent, or of an alloy of equal quantities of copper and silver). Admits of a fine polish, but soon tarnishes, first assuming a yellowish hue, which gradually changes to brown and finally to brownish-black; sometimes iridescent. Somewhat malleable.

B.B. it fuses readily and gives off the odor of arsenic. Insoluble in chlorhydric acid; soluble in nitric acid. Composition: $Cu_{18}As$. Analyses:

			Calculated.
Copper,	88·07	88·19	88·37
Arsenic,	11·81	11·41	11·63
Silver, Insoluble,	0·33	0·47	
	100·21	100·07	100·00

The material for the analyses was selected with the greatest care and was apparently quite pure.

It occurs coated with red copper, and a copper-salt resulting from its oxydation, probably olivenite. One boulder of forty pounds in weight has been found at the Pewabic Mine, Houghton County, Mich., and was mistaken for silver. The material for the above analyses has been kindly presented to me by John F. Blandy, Esq., of Philadelphia. According to the information received from him, the agent of the Albion Mine recognizes the same mineral as occurring in a small vein of from three to four inches in width, and about one mile from the Cliff Mine, at the Albion location. I have named the mineral in honor of Professor J. D. Whitney, who informs me that a mineral, which he found at the Minnesota Mine, is identical with my new species.

In its chemical relations it is of considerable interest, because it is another example in which a multiple of six equivalents of copper combines with one of arsenic, forming with domeykite and algodonite a beautiful series of arsenids of copper, viz:

Domeykite, - - - - -	Cu_6As.
Algodonite, - - - - - -	$Cu_{12}As$.
Whitneyite, - - - - -	$Cu_{18}As$.

(*To be continued.*)

ART. XLVIII.—*On Spontaneous Generation.*

1. *Remarks of Prof.* MILNE EDWARDS *on the value of certain facts as evidence of the spontaneous generation of animals*, made before the Academy of Sciences at Paris,* at the session of January 3, 1859.

Physiologists have long been divided on the subject of the origin of life in organized beings. The larger part believe that this force exists only where it has been transmitted; that from the creation of the species till the present time, an uninterrupted chain of possessors of this power has communicated it successively; and that dead matter has no power of organizing a plant or an animal unless it be submitted to the action of a living being or a germ that has proceeded from an individual of some species.

Others, on the contrary, have held that inert matter, under certain chemical and physical conditions, could take on life without the agency of a generating being; that plants and animals may produce themselves in all their parts without deriving the principle of existence from another living body; and that consequently life itself must be considered, not as a force which has been imparted peculiarly to organized beings, but as a general property of organizable matter manifesting itself under certain favorable conditions.

In my lectures and writings, I have often combatted this last doctrine; and the hypothesis of *spontaneous generation* has to-day so few supporters among zoologists, that I should have feared to abuse the patience of the Academy in discussing it at this time, had I not seen in the Report of a recent session of this body, that one of our correspondents, Mr. Pouchet, had made it the object of new researches and had arrived at conclusions, which, if right, sustain the idea that living beings may be made by the same general forces on which chemical combinations in inorganic nature depend. Since reading this memoir, I have thought it might be useful to submit to the judgment of my colleagues my reasons for rejecting its conclusions; and it appears to me desirable also to know the opinions of other physiologists on a point of so much importance: besides, the question reaches beyond the domain of the natural sciences, and we may look for additional light from our chemists.

Long before the invention of the microscope had enabled zoologists to discover the animalcules which are produced in

* Comptes Rendus, 1859, p. 23. The Zoologists and other members of the Academy who have here expressed their views on spontaneous generation, are at the head of their respective sciences in France.

myriads in waters containing an infusion of organic matters, it had been observed that dead bodies when left to putrefy often became populated with swarms of life; and as the intervention of no living being was manifest in their production, the old naturalists supposed them a product of the putrefaction which was in progress, believing that the material, after ceasing to pertain to a living being, could reorganize itself under a new form and so constitute animals which had no parent; accordingly, that life is not the cause, but the consequence of a certain mode of arrangement of the molecules composing these substances, and that this kind of molecular grouping could be determined by inorganic forces in nature.

The occurrence of maggots in carrion was one of the cases. But since the study of the origin of these animals by the Florentine Academy, happily named "del Cimento," and the exact investigations of Redi, one of its members, it has been well understood that these worms about dead bodies, far from being a result of spontaneous generation, are the brood of well known insects, species which find in such bodies the conditions requisite for development, and hence, through a marvellous instinct, deposit there their eggs.

The experiments of Redi, which date from the middle of the 17th century, left no uncertainty respecting these larves. But while very easy to establish the fact respecting animals as large as flies, it was far less so with regard to infusory animalcules, which are discernible only by means of the microscope, and whose germs are so excessively minute that they have escaped all the methods of observation which the science of optics has supplied. When, therefore, Lewenhoek and his successors made known the existence of these animalcules, the hypothesis of spontaneous generation regained favor. While some physiologists regarded them as derived from germs of extreme minuteness which were spread every where in nature, and floating as fine dust in the atmosphere, settled on all bodies to develop only where the conditions of air, water and organic decomposition favored; others denied the existence of germs, and supposed that under the dissolving action of the water, the dead organic substance took on life and so came out as new beings.

Analogy afforded a strong argument for the first of these opinions. The second has often been sustained by appeals to researches claiming that animalcules were produced under circumstances in which all germs from external sources were excluded, and all present in the waters used had been destroyed. Frey and several other observers have thought that they had succeeded in securing these conditions and still had found their infusions populated with microscopic plants and animals; whence the conclusion that these organisms were a result of spontaneous generation.

It does not pertain to me to pronounce on the origin of microscopic plants, for this difficult subject must be left to botanists. But as regards animals, I do not hesitate to say that the experimental conditions required to prove the truth of spontaneous generation have not been realized by any of the predecessors of Mr. Pouchet. And are the researches of this naturalist, that have recently been communicated to the Academy, free from the objections which are made against earlier experiments? I believe not: and before mentioning some observations I have had occasion to make on this subject, I will briefly state the reasons that lead me to this conclusion.

I do not question the facts stated by Mr. Pouchet. The point is, Have these facts the significance attributed to them? I believe not. His experiment is briefly as follows. After having boiled some water and kept the liquid from contact with the air, he puts it into contact with pure oxygen, and introduces a certain quantity of hay, which had been previously enclosed in a flask and heated for a half hour in a stove whose heat was carried up to 100° C. or to the boiling point of water. The infusion thus prepared was hermetically sealed, and after some days Mr. Pouchet found infusoria developed in it.*

To make these facts sure proof that the animalcules obtained were not derived from the hay put into the infusion, it must be shown that the heat of the stove had destroyed all the germs. Mr. Pouchet presumes that this is true, because on boiling in water the spores of a *Penecillum* he has seen that they were decomposed. But this reason does not satisfy me.

In the first place, was the hay, although enclosed in a flask and kept thirty minutes in a stove at 100° C. (212° F.), really carried up to the temperature of boiling water? Mr. Pouchet believes it; but I think to the contrary, and I think that physicists and chemists will judge so too. The equilibrium of temperature under such conditions is not established so promptly as this; it appears to me probable that the hay, enclosed in a glass vessel and surrounded by air in repose, both substances bad conductors of heat, was in reality heated but little by the heat of the stove during the short time it was exposed to it.

But supposing that the hay was heated up to 100° C., can we then conclude that the germs had lost their vitality and were incapable of development? No, for there is an important distinction here to be recognized between the action of heat on organized bodies which contain water and on those which are in the dry state. This follows directly from the researches, already old, of our learned colleague, Mr. Chevreul. Although in ordinary circumstances death takes place when animals are exposed to a

* See page 253 of this volume.

temperature sufficient to determine the coagulation of the hydrated albumen in their tissues, we know that this is not always so in the case of those which have been previously dried. In fact, fifteen years since, Mr. Doyère made known that certain animalcules, such as the *Tardigrades*,* after being sufficiently dried would preserve their vitality for several hours while exposed in a stove whose temperature is much higher than that used by Mr. Pouchet for his flask of hay. I have seen these animalcules resist thus the very prolonged action of a stove whose temperature stood at 120° Centigrade (248° F.); and in the researches of Mr. Doyère, the heat of the ambiant medium was carried to 140° C. (284° F.) without death ensuing from the heat.

What is true for the *Tardigrades*, animals of a very complex structure, may also be true for the germs of Infusoria in general; and I conclude that nothing in the trials of Mr. Pouchet authorizes us to infer that the germs of the animalcules obtained by this naturalist were not in the hay that was used in his experiment. I will even say that the experiments of our correspondent do not seem to me to add any new probability in favor of the hypothesis of spontaneous generation.

I have often made analogous experiments; and I have always found that the living animalcules which appeared in water containing dead organic matters, were increasingly rare the more complete the precautions employed for protecting the liquids from the introduction of germs. In more than one trial, I should have believed that spontaneous generation had taken place under my own eye, had I not, on reflecting on the conditions under which I was operating, perceived sources of error, and on setting these aside, observed negative results to multiply.

I will not occupy the Academy with the general recital of these trials, but will ask permission to recount briefly a single series of experiments in which some infusions, that if exposed to the air would in all probability have given birth to animalcules, afforded none when the imprisoned matters in the hermetically sealed vessel had been subjected to a temperature high enough to cause the coagulation of the contained albuminoid substances.

I placed in two tubes, having the form of test-tubes, the water and the organic matters for the trial. One of these tubes, which was two-thirds filled with air, was then closed by means of a lamp, and both this and the other tube were then plunged into a bath of boiling water. The bath was kept in ebullition long enough to establish an equilibrium between the water outside

* The Tardigrade animalcules are minute worm-shape animals about a fortieth of an inch in length, belonging to the Rotatoria of Ehrenberg, and therefore much higher in structure than the ordinary Infusoria.

and the liquid of the two infusions; and then the tubes were allowed to cool and left to themselves, care being taken to examine the contents from time to time. After some days, I found animalcules in the tube which remained open to the atmosphere, but *not a single one in that which had been hermetically sealed.*

I have been accustomed to cite these experiments in my lectures, but had not thought of bringing them before the Academy, because negative results acquire importance only when they have been obtained constantly in a large number of trials, and also because the spontaneous generation of animals appears to me so little probable that I would not devote time to the repetition of researches on a subject which seems to be already settled. Only in view of the communication of our correspondent, and the interest that experimenting in this direction may excite in our young physiologists, have I been induced to bring out these facts among the reasons for still rejecting the hypothesis of spontaneous generation as an explanation of facts connected with the multiplication of animalcules.

An hypothesis which is not necessary in order to understand the phenomena made known by observations, and which is in flagrant discordance with all that analogy teaches us, seems to have no right to a place in science. It may be that chemistry will be able to make all the kinds of substances which occur in the constitution of living bodies; but as to the genesis of living organisms without the concurrence of vital force, I see no reason for believing it. Until more amply instructed, I shall therefore continue to think that in the animal kingdom there is no such thing as spontaneous generation, and that all animals, large and small, are subject to the same law, and can exist only when they have been generated by living beings.

2. *Remarks on the same occasion*, by Mr. PAYEN, Professor in the Conservatoire Imperial des Arts et Metiers.

Some time in 1843, there occurred an alteration of the bread at Paris by a rapid growth of cryptogamic vegetation; and after having determined in connection with Mr. Mirbel the cause of the phenomenon, which had produced some excited dissatisfaction among the people, I endeavored to determine the temperature at which the sporules of the *Oidium aurantiacum* lost their germinative power. These sporules were heated at first for an hour to 100° C. (212° F.) in a tube inserted in an oil-bath. A part were then withdrawn and exposed in the proper circumstances for growth; and germination took place. The remainder of the sporules were then heated to 120° C.; and they neither underwent change of color nor lost their property of germination. Finally, they were heated to 140° C., when their appearance

was altered, the color became reddish-orange in place of brownish-yellow, and the germinative power was destroyed.

These results sustain, as regards the lower orders of vegetation, the opinion expressed by Prof. Milne Edwards respecting animalcules.

3. *Remarks on the same occasion*, by A. DE QUATREFAGES.

I have often expressed on the subject of spontaneous generation similar opinions to those of Milne Edwards; and I now give my full adhesion to the conclusions of my learned associate. I take the floor only to communicate to the Academy an observation, which, although incomplete, confirms ideas now generally admitted. [De Quatrefages adds some facts sustaining his opinion.]

4. *Remarks on the same occasion*, by Dr. CLAUDE BERNARD.

Among a large number of experiments which I have made to ascertain the influence of saccharine substances in liquids where microscopic vegetation was developed, I will cite one, as it bears directly on this subject of spontaneous generation now under discussion.

On the 1st of September, 1857, I put into two glass flasks, each half a litre in capacity, about fifty cubic centimeters of a same dilute solution of gelatine in water to which some thousandths of cane-sugar had been added. The liquid was then kept boiling in the two flasks for a quarter of an hour, the tubular neck of each having been previously drawn out so that it could easily be sealed. Up to this point there was no difference between the flasks. Now, when the flasks were still boiling and filled with steam, a difference was begun by allowing ordinary air to enter one, and highly heated air the other. To accomplish this, while ebullition was going on, the neck of one of the flasks was connected with one of the extremities of a porcelain tube filled with fragments of porcelain and brought up to a red heat by a furnace; at the other extremity the porcelain tube was terminated in a glass tube of fine bore, so that the air should enter gradually and pass very slowly over the red-hot porcelain. Thus situated, the vapor of the liquid in ebullition rose into and filled the porcelain tube, and even passed out at the end of the fine tube. The lamp was then removed to arrest the ebullition; and by degrees the steam was condensed and the outside air (air of the laboratory) entered to take its place, passing through the red-hot porcelain tube above described. After the liquid had cooled, the flask was hermetically sealed at the neck.

The other flask was allowed to cool without any connection with the porcelain tube, and the atmospheric air entered freely. When the flask was cooled it was sealed like the other.

The two flasks were then placed in the same conditions, exposed to the light and to the ordinary temperature. After ten or twelve days, at the surface of the flask containing the ordinary air, vegetation was visible, a well-characterized mould, whilst in that which had received the heated air the liquid remained perfectly limpid, and without any thing on its surface. After a month the mould had much increased in the former, while nothing had appeared in the latter, except that the water had slightly lost its clearness. After six months (March 4, 1858) the mould remained stationary in the former, while in the other the liquid continued the same, without any trace of mould.

The extremities of the two flasks were now broken under mercury. In the case of the one with heated air, considerable mercury was absorbed, but none in the other. The air of the two flasks being analyzed, no oxygen was found in either. The air from the flask with ordinary air contained 13·48 per cent of carbonic acid, that of the other, in which no mould had formed, 12·43 per cent.

The liquid of the flask with ordinary air had a putrid and very disagreeable odor, while the other had none. These liquids were examined by Mr. Montagne; and our Associate ascertained that the mould developed in the flask with ordinary air was the *Penecillum glaucum*, which was in full fructification; in the other he found no trace of any vegetable or animal organism.

It is plain that this experiment, like those which have been before cited, is not favorable to the hypothesis of spontaneous generation.

5. *Remarks on the same occasion and subject by the chemist* DUMAS.

Dumas stated that he was in full agreement with his honorable Associates. For thirty years he had had under careful examination the question on which Prof. Milne Edwards had instructed the Academy with so high authority, and he had arrived at precisely the same conclusions.

He was incited to experiment on the subject by the publication of Mr. Frey, who had announced results analogous to those communicated to the Academy by Mr. Pouchet.

In his experiments he has assured himself that organized matters heated to 120° C. or 130° C. with water artificially made by means of hydrogen and oxyd of copper, and with artificial air in closed tubes, the glass of which had been recently heated to a red heat, produced neither vegetation nor animalcules. On opening these tubes and allowing ordinary air to enter, there was soon an appearance of vegetation and animalcules. These results had surprised him, as he was disposed to think that the germs of these plants and animalcules might be distributed in

the organized matter as well as in the air itself, and that certain of these germs might well be of a nature to resist a temperature of 100° C. or even a higher temperature.

As the Tardigrades when absolutely dry resist 140° C., and the sporules of *Oidium aurantiacum* 100° C. in a moist medium, it will not suffice in order to establish the hypothesis of spontaneous generation, that living beings should sometimes appear in boiling water in contact with artificial air and with the presence of organic matters that had before been heated, especially if these matters were heated when dry. When among these inferior animals and plants, life is suspended by absolute desiccation to return to action again on a return of humidity, the being so treated is in that state of latent animation which belongs to germs. It is hence a matter of astonishment that on putting heated organic matters into connection with oxygen and artificial water, we do not sometimes find living beings to appear. Even such an observation as this, would not therefore suffice to establish the theory of spontaneous generation, or prove that the germs of these beings were not previously deposited in the organic matters employed. But, in fact, whilst animalcules appear when the ordinary air has access, without this access under the precautions mentioned they do not appear.

6. *Note on Spontaneous Generation*, by James D. Dana.

1. There is a well-known principle in the system of nature that deserves to be considered in this connection. The principle is so fully sustained by all research both in chemistry and zoology, including the important experiments above mentioned, that it may well carry with it great weight, and quiet both apprehension and expectation on this subject. It is this:—The forces in life and inorganic nature act in opposite directions, the former *upward*, the latter *downward.*

The vital force, in the organic substances it forms, *ascends* through vegetable and animal life to an exalted height in the scale of compounds at an extreme remove from saturation with oxygen; inorganic force *descends* towards the saturated oxyd. The former reaches a point which from its very elevation is one of great *instability;* the latter tends towards one of perfect *stability.* There is hence a counterpart or cyclical relation between the two great lines of action in nature.

As some readers of these remarks may not be familiar with chemistry, a further word of explanation is added.

When an element unites with its full allowance of oxygen, as determined by its affinities, it is in a sense saturated with it. Since the attraction of the elements for oxygen is the most universal and, in general, the strongest in nature, the oxyds as a

class are the most stable of compounds; the rocks, the earth's foundations, are made of them. But evanescence and unceasing change are in the fundamental idea of the living structure; and consequently the material of the plant or animal contains only oxygen enough to give increased instability to the combination. Moreover the compounds augment in instability, through this and other ways, with the rise in the grade of organic life, and reach probably their farthest extreme in this respect in the brain. Here then is the summit of the series of compounds which arise under the agency of life. The stable oxyd is at the lower end of the series in nature, the material of the brain at the upper. Passing from the latter condition towards the former is therefore a real descent; and it is the natural downward course of inorganic forces;—while passing towards the latter is as truly an ascent; it is the counter-movement of life.

The plant through its vital functions may take carbonic acid, and from it, continue to elaborate the organic products constituting vegetable fibre, until a whole tree of such material is made, and then produce the higher material of the flower and seed. The animal may then go to the plants and use them in making a still higher class of products, muscular fibre and nerve. After all this is done, now turn over the material to the action of chemical and physical forces,—and the work of years of life is soon pulled down from its height, and one part after another descends towards that state of comparative inactivity, the condition of an oxyd. Chemistry makes organic products by commencing with those of a higher grade than the kind to be made, but not otherwise. Albumen is a prominent material of the egg; and chemistry has not succeeded in making dead albumen, much less living.

The very relation of life to chemistry is therefore evidence that chemistry cannot make life; it works in just the reverse direction. And in this reciprocal relation one of the profoundest laws of nature is exhibited. It leads the mind to recognize one author for both, and not to imagine that one side in the cycle has generated the other.

2. There is another consideration, which, if it has not the force of demonstration, may help the mind to understand the extent of the transition from dead matter to living.

(*a*) In ordinary *inorganic* composition, there is the simple formation of inorganic particles, and, on consolidation, their aggregation into crystals, the perfect individuals of inorganic nature. With the enlargement of the crystal there is no gain of new powers or qualities: it simply exists. In fact, in entering this state of perfection, there is *a loss of latent force;* for the gas is the highest condition of stored or magazined force in inorganic

nature, the liquid the next, and the solid the lowest, this condition of power being related directly to the amount of heat.

(*b*) The *plant* grows from its germ, enlarges, accumulates force storing it away in vegetable fibre, and accomplishes its highest functions in its blossoms and fruit. But there is here only *latent or stored force* generated, besides that which is used up in growth, and *no mechanical* force. The minute spore or reproductive cellule of some seaweeds has locomotive power, but it is lost at the commencement of germination; and the plant is ever after as incapable of self-locomotion as a rock.

(*c*) In the *animal*, there is not only a storing of force in animal products (the fifth and highest grade of stored force in nature), but there is also increasing *mechanical* force from the first beginning of development. It is almost or quite zero in the germ; but from this, it goes on increasing until in the horse, it gets to be a one-horse power; or in the ant, a one-ant power; and so for each species. And in addition to mechanical force, there is, in the higher group, the more exalted *mental force;* for the mind, while not itself material, is yet so dependent on the material, that its action draws deeply upon the energies of the body. To make an animal germ is then to make a particle of albuminoid substance that will grow and spontaneously develop a powerful piece of enginery, and continue a system of such generations through ages of reproduction.

The creation of any such animal germ out of dead carbon, nitrogen, hydrogen and oxygen, or any of their dead compounds, is therefore opposed to all known action or law of chemical forces; and as much so, the creation of a vegetable germ from inorganic elements.

Moreover, it is seen that the two kingdoms, the vegetable and animal, have their specific limits and comprehensive reciprocal relations, and are obviously embraced as parts of one idea in a single primal plan:—not a plan involving the generation of one out of the other, or of either out of inorganic nature, but of the three, through some Creating Power higher than all.

ART. XLIX.—*Eruption of Mauna Loa, Hawaii.*

THE central crater of Mauna Loa is again in action. According to a letter from the Rev. T. Coan of Hilo and the public papers, the eruption began on Sunday the 23d of January last.

This is the fourth great eruption since the beginning of the year 1843. Previous to that time *Kilauea*, the still more spacious crater on the eastern slopes of the mountain, had been often in violent action, while the summit crater was quiet, and

had long so remained. The account of boiling fires in the pit at the summit, brought down by the unfortunate Douglas in the year 1834 was disbelieved, because of the accustomed quiet of the crater, in addition to some evident exaggerations in his description and the absence of any manifestations of fires distinguishable from the foot of the mountain.*

Kilauea discharged its lavas through the sides of the mountain in 1823, June 1832, and June 1840. The lower pit, which was 400 feet deep after the eruption of 1840, had filled up again by 1848, and the bottom had become raised by the overflows of the pool even above the level of the old black ledge. In the course of these changes a broad dome was raised over the site of the great lake of boiling lavas in the southwestern extremity of the crater; in a basin at the centre of the dome the lavas were still smoking, and boiling or subsiding with its varying phases. Eleven years have since passed, and Kilauea has had no new eruption. Mr. Coan in his recent letter (Feb. 3, 1859,) observes:

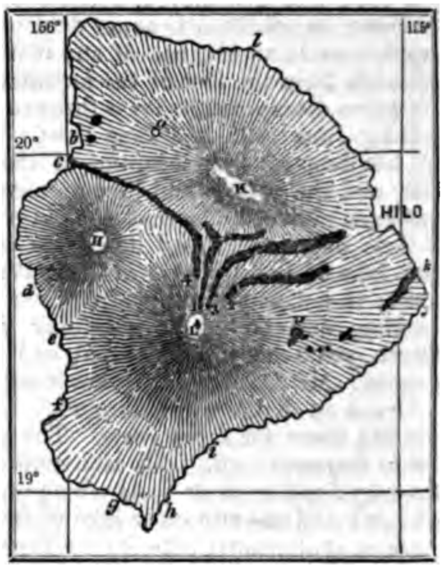
"I was at Kilauea last August. No striking changes have occurred there for three years. The great lake now some 500 feet in diameter—still boils and sputters lazily in the centre of the deep depression or basin which occupies the locality of the old dome and the still older lake of far larger dimensions. The action in it alternates between a refrigeration and a breaking up of the whole surface with intense ebullition. Mr. Sleeper of Charlestown, tells me that during a recent visit to this pool he saw it throw up jets of fire 100 feet high."

After the last eruption of Kilauea, the action of the central crater of Mauna Loa (called Mokua-weo-weo) began to revive. In January 1843 there was an outflow which commenced at a height of 13,000 feet, and extended on for 25 or 30 miles running northward toward Mauna Kea, and part northwestward. It is No. 1 in the annexed map. Again on the 17th of February, 1852, another eruption (No. 2,) took place, making its first appearance near the summit, but after three days, beginning its principal outflow from a point 10,000 feet above the sea, where there was a fountain of lava 1000 feet in diameter and 300 to 700 feet high described by Messrs Coan, Fuller, and others (this Journal, [2], xiv, 219, 254, xv, 63). It flowed off to the eastward with a winding course for about 40 miles. In August 1st, 1855, a third eruption (No. 3 on the map) took place, beginning at a height of about 12000 feet, according to Mr. Coan, and continu-

* This word foot, although correctly used, is sure to convey a wrong impression unless it is remembered that Mauna Loa has a breadth of 50 miles, and a height of only 2½ miles. By laying off an equilateral triangle having the base 20 times the height, and then rounding a little the top, an approximate section will be obtained. It will be improved by extending the eastern slope one fourth farther at an angle diminishing gradually to one degree. The crater Kilauea is but 3,970 feet above the sea, although 18 to 30 miles from the coast.

ing its progress for a year and a half, it stopped within five miles of Hilo. (This Journal, xxi, 100, 139, 237, 241, xxii, 240, xxiii, 435).

Finally, on the 23d of last January, according to Mr. Coan, a fourth great outflow commenced: making three eruptions at intervals of 8½ years, and four from January, 1843. Mauna Loa is hence quite taking the lead in activity among the earth's larger volcanoes. And as Kilauea has remained quiet since the older crater began its outbreaks, it would seem as if the mountain had transferred to the latter its principal activity. Yet according to all reports, hitherto, Kilauea, although the larger crater and an open vent at a level 10,000 feet lower, has shown no signs of sympathy in its lavas with the violent action at the summit.



ISLAND OF HAWAII.

L, Mauna Loa; K, Mauna Kea; H, Mauna Hualalai; P, Kilauea or Lua-Pele; 1, Eruption of 1843; 2, of 1852; 3, of 1855; 4, of 1859; *a*, Waimea; *b*, Kawaihae; *c*, Waimanalii; *d*, Kailua; *e*, Kealakekua; *f*, Kaulanamauna; *g*, Kailiki; *h*, Waiohinu; *i*, Honuapo; *j*, Kapoho; *k*, Nanawale; *l*, Waipio. The courses of the currents, excepting that of No. 4, are from a manuscript map by Mr. Coan.

From the letter of Mr. Coan and the notices in the public paper of Honolulu referred to, we derive the following accounts of the recent eruption. It has yet been but imperfectly explored.

The editorial writer in the "Commercial Advertiser" of Honolulu, in his visit to the region, reached the central plain of the island between Mauna Loa, M. Kea and Hualalai, elevated about 4000 feet above the sea. He says:

"This new crater, for which we can find no native name except '*Pele hou*,' (the new eruption,) is located on the northern slope of Mauna Loa, at an elevation of, say 6,500 feet, above the sea, and at an equal distance below the level of the summit of the mountain. It is some ten miles or so more to the westward, and about 4000 feet lower down, than the last eruption of 1855. The course of the stream, from its source to the sea, we judge to be nearly N. W. by N. The crater bears due east from Kailua by the compass, and is about 24 miles from that harbor in a straight line. Its latitude, as near as we are able to determine without instruments, is 19° 37′, and the longitude 155° 40′.

From the distance at which we observed the crater, about ten miles, and from various points of observation, it *appeared* to be circular, its width being about equal to its breadth, and perhaps 300 feet across the mouth. This may be too moderate an estimate, and it may prove to be 500 or even 800 feet across it. The rim of the crater is surrounded or made up of cones formed from the stones and scoria thrown out. The lava does not simply run out from the side of the crater like water from the side of a bowl, but is thrown up in continuous columns, very much like the Geyser springs, as represented in school geographies. At times this spouting appeared to be feeble, rising but little above the rim of the crater, but generally, as if eager to escape from the pent-up bowels of the earth, it rose to a height nearly equal to the base of the crater. But the columns and masses of lava thrown out were ever varying in form and height. Sometimes, when very active, a spire or cone of lava would shoot up like a rocket or in the form of a huge pyramid to a height nearly double the base of the crater. If the mouth of the crater is five hundred feet across, the perpendicular column must be eight hundred to one thousand feet in height! Then by watching it with a spyglass, the columns could be seen to diverge and fall in all manner of shapes, like a beautiful fountain.

This part of the scene was of wonderful grandeur. The fiery redness of the molten lava, ever varying its form, from the simple gurgling of a spring to the hugest fountain conceivable, is a scene that will remain on the memory of the observer till death. Large masses of red-hot lava, weighing hundreds if not thousands of tons, thrown up with inconceivable power to a great height, could be seen occasionally falling outside or on the rim of the crater, tumbling down the cones and rolling over the precipice, remaining brilliant for a few moments, then becoming cold and black, and lost among the surrounding blocks of lava.

A dense heavy column of smoke continually rose out from the crater, but always on the north side and took a northeasterly direction, rising in one continuous column far above the mountain, to a height of perhaps 10,000 feet from the crater.

On leaving the crater, the lava stream does not appear at the surface for some distance, say an eighth of a mile, as it has cut its way through a deep ravine or gulch, which hides it from the eye. How deep this gulch may be is all conjecture, as it is impossible to get near enough to look into it, but it probably is several hundred feet deep. The first then that we see of the lava after being thrown up in the crater is its branching out into various streams some distance below the fountain head. Instead of running in one large stream, it parts and divides into a great number, spreading out over a tract of five or six miles in width. For the first six miles from the crater, the descent is rapid, and

the flow of the lava varies from four to ten miles an hour, according to the descent. But after it reaches the plain, where it is level, the stream moves more slowly. Here the streams are not so numerous as higher up, there being a principal one which varies and is very irregular, from an eighth to half a mile in width, though there are frequent branches running off from it. This principal stream reached the sea near Wainanalii, or about fifteen miles south of Kawaihae, on the 31st, after a flow of eight days from the time that the eruption commenced on the 23d of January. This stream, on reaching the sea, spread out to about half a mile in width, and clouds of steam rose several hundred feet high, and covered the region.

The length of the lava stream from the crater to where it enters the sea at Wainanalii, we estimate to be thirty-eight miles. For the first ten miles from the crater, the flow is divided into many streams—perhaps as many as fifty—but lower down, it is confined to one or two principal streams with frequent branches to the right and left."

Another writer in the same paper, L. Lyons, dating Waimea, Feb. 4, makes the important statement that an outbreak took place first "very near the top of the mountain," and that the outflow at 6500 feet was only a continuation of the eruption.

"On Sabbath, Jan. 23d, volcanic smoke was seen gathering on Mauna Loa. In the evening the mountain presented a grand yet fearful spectacle. Two streams of fire were issuing from two different sources, and flowing, apparently, in two different directions. The whole region, earth and heaven, were lighted up, and even the interior of our houses received the lurid volcanic light direct from its source. In the morning of the second day, we could discern where the eruptions were. One appeared to be very near the top of the mountain, but its stream and smoke soon after disappeared. The other was on the north side, further below the top, and was sending out its fires in a northwesterly direction. On the second and third nights, the dense smoke and clouds prevented us from a fair view of the action: but on the four following nights we had a view—and such a scene! It seemed as though the eye could never weary in gazing at it. The burning crater seemed to be constantly enlarging and throwing up its volumes of liquid fire above the mouth of the crater—I will not venture to say how high—and the fiery stream rolled onward and onward, still adding grandeur and terror as it proceeded, till, on the morning of the 31st, about sunrise, the stream was compelled, though reluctantly, to stop, by meeting the waters of the ocean. Even then its resistless and opposing energy carried it on some distance into the sea. The poor inhabitants of Wainanalii, the name of the village where the fire reached the ocean, were aroused at the midnight

hour by the hissing and roaring of the approaching fire, and had but just time to save themselves. Some of the houses of the inland portion of the village were partly surrounded before the inmates were aware of their danger. Wainanalii is near the northern boundary of North Kona, and about twelve or fourteen miles from Kawaihae. It is, of course, all destroyed, and its pleasant little harbor filled up with lava. The volcanic stream was one mile wide or more in some places, and much less in others. It crossed the Kona road and interrupted the mail communication. The whole distance of the flow from the crater to the sea is some forty miles.

Last night (the 3d Feb.) the volcano was in full blast, and the burning stream seems to have taken another direction."

Mr. Coan writes from Hilo on Feb. 3, having projected but not yet undertaken a journey of exploration.

"On the 23d ult. Mauna Loa opened near its summit and out rushed a flood of lavas, which made unusually rapid progress in its descent. So vigorous was the action and so immense the floods of lava poured out, that, for a long time, there seemed no blackening and refrigerating process on the surface, but a vast incandescent river rushing madly down and throwing up such an intense glare as appeared like a consuming mountain and a burning firmament. The course of the stream was north, until it was diverted by the base of Mauna Kea, when it turned west-northwest and flowed towards the opposite coast of our island. So great has been the light and so vehement the action, that many pronounce it the greatest eruption we have ever had in so short a time.

At the present time there is no light and but little smoke visible from Hilo at the summit or side of the mountain, but the light is still intense all over the isthmus between the mountains.

The present eruption commenced very near the point of the one in 1843 [at the summit] which cost me such fatigue and danger in exploring. The direction of the lava stream or streams is, also, very nearly the same."

This eruption appears to have been similar to that of 1855 in its jet or fountain of lavas at the great outbreak. The first outbreak at the summit shows that the column of lavas of Mauna Loa had the height of about 13,000 feet, or 9500 above the level of the bottom of the crater of Kilauea. The second outbreak at a height of 6500 feet, was therefore 6500 feet below the first; and it proves that a column of 6500 feet of heavy liquid lavas was acting by its pressure in producing the fountain of lavas described. Like all the preceding eruptions of the grand old mountain, there were no great shakings or subterranean sounds, so common in the more blustering action of little Vesuvius. There is rock material enough in Mauna Loa to make *one hundred and twenty-five* Vesuviuses. J. D. D.

SCIENTIFIC INTELLIGENCE.

I. PHYSICS AND CHEMISTRY.

1. *Researches on the Thermic action of the Solar Spectrum.*—MÜLLER has communicated an interesting memoir upon the subject of the thermic action of the solar spectrum, a subject which has hitherto attracted comparatively little attention. In his introduction, the author in the first place, briefly reviews the experiments of Melloni, who confined his attention almost exclusively, to the determination of the position of the maximum temperature in the spectrum. Experimenting with a prism of rock salt, Melloni found the maximum of heat in a position which lies about as far outside the red limit of the spectrum as the place of passage from the green to the blue is distant from the red end. The Italian physicist gave however no numerical data from which the thermic curve in the spectrum could be deduced. Melloni also, who had previously adopted the opposite view, afterward maintained the perfect identity of rays of light and heat of the same degree of refrangibility. This last view as to the identity, was also adopted by Masson and Jamin, who found that all the rays of heat which lie within the visible spectrum are equally well transmitted by rock salt, rock crystal, alum, glass, etc. That consequently the unequal transcalency of these substances is only occasioned by their unequal capacity of absolving the rays of heat which are less refrangible than the red. They have not however, published the details of their experiments.

The merit of first communicating measurements of the temperature at different points of the spectrum, obtained by means of the thermoelectric battery, belongs to Franz. He found that in a spectrum which is pure enough to exhibit Fraunhofer's lines the thermic effects are so slight that measurements are out of the question. As Franz' numerical data were obtained by means of a flint glass prism, which absorbs a considerable number of dark-rays of heat, the curve of intensity, constructed upon his numbers, does not correspond to the distribution in a complete heat spectrum. This can only be obtained by means of a prism of rock salt. The instruments employed by Müller, consisted of a thermo-electric pile of 40· pairs of bismuth and antimony, of a multiplier of 3700· windings, and of a linear thermo-electric pile of 15· pairs. The sun's rays with which he experimented, were introduced into a dark room, by means of a Silbermann's heliostat.

Before undertaking experiments on the distribution of heat in the spectrum, the author endeavored to attain his object by investigating the absorbing action of colored liquids upon the rays of heat. This method requires us to assume the identity of rays of light and heat of the same degree of refrangibility. The liquids employed were enclosed between parallel glass plates, and optically analysed by means of a prism. They consisted of pure water, a solution of cochineal, a solution of bichromate of potash, a solution of chlorid of copper and a solution of ammonia sulphate of copper.

By directly comparing the quantity of heat transmitted through these
uids, with the character of the light also transmitted, the author found at the heating power of the less refrangible rays of the solar spectrum, mely of the red, orange and yellow rays, is much greater than that of e green, blue, indigo and violet.

After some preliminary experiments with a glass prism, the author proeded to use a prism of rock salt, with the linear thermo-electric battery. om the numerical data obtained, he constructed the curves of thermic tensity in prisms of crown-glass, and of rock salt. This curve shows at the dark rays of heat in the spectrum, beyond the red, occupy, in e case of crown-glass, a space which is almost as long as the entire sible spectrum, and this result corresponds nearly with those of Franz. the spectrum obtained by means of a prism of rock salt, the thermic aximum lies still farther outside of the red, than in the case of the ectrum with the glass prism, and the actual distance corresponds with e measurements of Melloni above mentioned. The dark thermic proigation of the spectrum is, according to these experiments not greater r rock salt than for glass.

The above experiments show that the dark rays of heat which are conined in the solar spectrum, extend far beyond the red limit of the visible ys, and that for a crown-glass spectrum, Fraunhofer's line B lies about the middle between the violet end of the spectrum and the extreme rk rays of heat. And since the index of refraction of crown-glass for e line H is about 1·546 and for B about 1·526, it follows that the index refraction of the extreme dark rays of heat in the solar spectrum, is out 1·506.

The results of the author's experiments, as we shall see farther on, do t agree with Cauchy's formula for dispersion, which is intended to exess the relation between the wave length and the index of refraction. is relation the author endeavors to express by an empirical formula the form

$$w = a + be + ce^2 \quad . \quad . \quad . \quad . \quad (1.)$$

which w represents the wave length, e the index of refraction, and a, and c constants determined by experiment. This formula gives for the ave length of the extreme rays of heat in the solar spectrum and for index of refraction of 1·506, the value

$$w = 0{\cdot}00177^{\mathrm{mm}}.$$

e same result very nearly is obtained by a graphical construction, hich gives

$$w = 0{\cdot}0019^{\mathrm{mm}}.$$

e author takes the mean of these two determinations, namely,

$$w = 0{\cdot}00183^{\mathrm{mm}},$$

the wave length of the extreme dark rays.

The wave length of the extreme fluorescent rays in the sun's light is, cording to Esselbach's experiments, 0·0003.

The wave length 0·0006, corresponding to Fraunhofer's line D in the ange, is the next lower octave of these most refrangible rays.

The second lower octave with a wave length 0·0012 falls in the middle the dark rays of heat of the solar spectrum.

The third lower octave with a wave length 0·0024 falls outside of the limit of least refrangibility.

In all therefore the solar spectrum embraces somewhat more than two and a half octaves.

In conclusion, the author investigated the distribution of heat in the diffraction spectrum, the apparatus employed being a ruled surface of smoked glass (*Russgitter*), similar to that employed by Eisenlohr, and a linear thermo-electric battery of fifteen pairs, but found the thermic effects so small that he was obliged to abandon the hope of obtaining reliable results in this manner. He however deduces the curve of distribution of the heat in the diffraction spectrum from that of the refraction spectrum. From this curve, it appears that in the diffraction spectrum the dark rays of heat occupy a space which is about three and a half times as broad as the whole visible spectrum.

In a second memoir, the author returns to the subject of the disagreement of his experiments with Cauchy's formula for dispersion above alluded to. If n represents the index of refraction for a particular ray, λ the corresponding wave length, Cauchy's formula for dispersion is

$$\frac{1}{n^2}=a+\frac{c}{\lambda^2} \qquad (1.)$$

neglecting the higher powers of $\frac{1}{\lambda}$.

If we substitute in this equation the values $\lambda = 0{\cdot}000396$ for the line H, and $n = 1{\cdot}546$ for crown-glass, we have

$$0{\cdot}41839 = a + c\,.\,6376900. \qquad (2.)$$

If we substitute the value $\lambda = 0{\cdot}00069$ for the line B and $n = 1{\cdot}546$ we have

$$0{\cdot}42943 = a + c\,.\,2100400. \qquad (3.)$$

By combining these two equations we find

$$a = 0{\cdot}43436$$

$$c = -0{\cdot}0000000023477,$$

and substituting these values in equation (1.) we have

$$\frac{1}{n^2} = 0{\cdot}43436 - \frac{0{\cdot}0000000023477}{\lambda^2}. \qquad (4.)$$

This is Cauchy's formula for the special case that n represents the index of refraction for crown-glass, and λ the corresponding wave length in the air. For $\lambda = \infty$ we have

$$\frac{1}{n^2} = 0{\cdot}43436 \text{ or } n = 1{\cdot}516,$$

and this is the least value of the index of refraction which is possible according to Cauchy's formula. Hence it appears that according to Cauchy's formula when the index of refraction diminishes from 1·546 to 1·526, the wave length diminishes from $0{\cdot}000396^{mm}$ to $0{\cdot}00069^{mm}$; when however the index diminishes from 1·526 to 1·517 the corresponding wave length ought, according to the formula, to increase from 0·00069 to infinity, a result which to say the least is extremely improbable.

For all values *less* than 1·517 and therefore for 1·506, equation (4.) gives imaginary values for λ. But by taking into consideration the influence which the ponderable particles exert upon the atoms of the ether which was neglected by Cauchy, Redtenbacher develops the formula

$$\frac{1}{n^2}=a+b\lambda^2+\frac{c}{\lambda^2}\cdots \qquad (5.)$$

This formula agrees with observation very well within the limits of the visible spectrum. When applied to Müller's index of refraction 1·506 for the extreme heat rays it gives for the corresponding wave length λ the value $0·0048^{mm}$, which is more than twice as great as that above determined by the author. Müller remarks that this difference is not surprising when we consider how uncertain is the application of empirical formulas far beyond the limits for which their coefficients are determined. In any event the value $\lambda = 0·0048^{mm}$ is much nearer the truth than that deduced from the purely empirical formula. If we adopt this determination, $0·0048^{mm}$ for the wave length of the extreme dark rays of heat, we find that the entire solar spectrum embraces four complete octaves, of which not quite one is made up of the visible spectrum.—*Pogg. Ann.*, cv, 337, 543. W. G.

2. *On the Preparation of Chromate of Lead, for use in Elementary Analyses;* by Dr. H. Vohl, (Liebig's Annalen, April 1858, p. 127, cited from Chem. Gazette, No. 380, p. 319).—The employment of chromate of lead in elementary analyses, in which it has many advantages over peroxyd of copper, is considerably limited, partly by its cost, and partly by its troublesome preparation; moreover, it could not hitherto be restored to its original condition like oxyd of copper which has been used, so that after it has served twice or at the utmost three times, it has become completely useless. The behavior of the nitrates to oxyd of chromium at a red heat, led the author to examine into the action of nitrate of lead upon the oxyd of chromium. He mixed together one equivalent of each substance in fine powder, and heated the mixture in a porcelain crucible over the spirit-lamp. A considerable reaction very soon took place. The mass caked together, and a great quantity of nitrous acid was evolved. When the evolution of gas had ceased and the mass was more strongly heated, it fused, and on cooling furnished a radiately crystalline body of a dark reddish-brown color, which, when triturated, gave a brownish-yellow powder, and proved to be pure chromate of lead. When this salt is employed in elementary analyses, it is principally only the chromic acid that is deprived of its oxygen; and used chromate of lead may be again converted into the pure salt by moistening it with nitric acid and afterwards calcining it.

3. *On the Solubility of Sulphate of Strontia in Nitric Acid, Muriatic Acid, and Acetic Acid;* by R. Fresenius, (Liebig's Annalen, May, 1858, p. 220, cited from Chem. Gazette, No. 381, p. 338).—According to the author's previous experiments, 1 part of sulphate of strontia dissolves in 11,000 to 12,000 parts of water containing a little muriatic and sulphuric acid, that is, in a fluid such as is obtained when chlorid of strontium is dissolved in water and the strontia is precipitated by an excess of sulphuric acid. Sulphate of strontia is, however, unequally soluble in fluids containing a somewhat larger amount of nitric acid, muriatic acid, and even acetic acid. This must be taken into consideration in analyses.

a. Pure freshly precipitated sulphate of strontia was digested in the cold for two days with dilute sulphuric acid of spec. grav. 4·8. 150 grams of the filtrate left 0·3451 gram, so that 1 part dissolved 435 parts. In a second experiment the proportion was 1 : 429. The average is 1 : 432.

b. Another portion of sulphate of strontia was digested in the cold for two days with dilute muriatic acid of spec. grav. 8·5. 100 grams left 0·2115, and another 100 grams 0·2104 gram. The average solubility of sulphate of strontia in muriatic acid of the above strength is therefore expressed by the proportion 1 : 474.

c. A third portion was digested in the cold for two days with pure dilute acetic acid containing 15·6 per cent of hydrated acetic acid. 100 grams of the filtrate left 0·0126 and 0·0129 gram. This gives the average 1 : 7843.

4. *Ammoniacal Solution of Protoxyd of Nickel, a means of distinguishing Silk and Cotton;* by Professor SCHLOSSBERGER, (J. f. pr. Chem., lxxiii, p. 369, cited from Chem. Gazette, No. 383, p. 372).—The violet-blue solution of freshly precipitated hydrate of protoxyd of nickel exerts an extremely remarkable action upon silk. If silk threads be brought in contact with a drop of this solution under the microscope, peculiar vermicular movements are observed in it, and at the same time they swell up considerably and acquire a yellow color. Soon afterwards the outlines become pale, in part (with raw silk) accompanied by considerable inflations or ruptures of the external envelopes of the fibres, and finally complete solution takes place. If silk be thoroughly kneaded up in a test-glass by means of a glass rod with the blue solution of nickel, it soon becomes of a brownish yellow color, resembling that of hydrated oxyd of iron; it then becomes slippery and gelatinous, and at last furnishes a brownish yellow solution.

If the silk fibres be washed with water in the first stage of their alteration by the author's new reagent, all further action ceases; in later stages of change, they are also fixed by washing. The same thing is effected by a drop of weak acid, by the addition of which the fibre also loses somewhat in volume, and becomes colorless.

Solutions of alkaline salts do not precipitate the solution of silk, nor do solutions of sugar and gum. It is remarkable that a solution of $Cl\,NH^4$ restores the original violet-blue color to the brownish yellow solution of silk in $NiO\,NH^3$, without separating anything. The solution of silk and nickel is abundantly precipitated by acids, and this precipitate (in colorless flakes of the aspect of hydrate of alumina) is permanent, when the acids are not too strong. The fluid exhibits a greenish color.

Cellulose (cotton) is not at all altered, even by immersion for several days in the solution of $NiO\,NH^3$; after lying in it for three days, the fibres of cotton still presented their original form under the microscope, and there was no trace either of swelling or coloration. Potato-starch also did not swell up in it; inuline was gradually dissolved.

No analogous action has yet been produced upon silk by means of solutions of CoO, ZnO, and Al^2O^3 in NH^3. In the coloration, swelling, and solution of silk by NiO, it is essentially a matter of indifference whether the silk employed be raw silk, or silk deprived of its dressing by boiling.

5. *The Discovery of the Composition of Water*, (Athen., No. 1635, Feb. 26, 1859).—Mr. Bennett, of the British Museum, has addressed a letter to Sir Benjamin Brodie, Bart., which contains indisputable evidence in favor of Cavendish's claim to the discovery of the composition of water. The evidence was discovered by the late Robert Brown, Esq., and is not derived from any unpublished document, but forms part of a section of De Luc's 'Idées sur la Météorologie,' which, although specially entitled "*Anecdotes relatives à la découvertes de l'Eau sous la forme d'Air*, appears entirely to have escaped the notice of those who have advocated Cavendish's claims. It is the more conclusive as coming from De Luc, the "*ami zélé*," as he justly terms himself, of Watt, and who, in relation to this question, believed himself "à portée d'en connoître toutes les circonstances."

The testimony of De Luc is as follows:—"Vers la fin de l'année 1782, j'allai à *Birmingham*, où le Dr. Priestley s'étoit établi depuis quelques annèes. Il me communiqua alors que, M. Cavendish, d'après une rémarque de M. Warltine, qui avoit toujours trouvé de l'eau dans les vases où il avoit brûlé un mélange de *l'air inflammable* et *d'air atmosphérique*, s'étoit appliqué à découvrir la source de cette eau, et qu'il avoit trouvé qu'un mélange *d'air inflammable* et *d'air déphlogistique* en proportion convenable, étant allumé par l'étincelle électrique, se convertissoit tout entier en *eau*.—Je fus frappé au plus haut degré de cette découverte."—*Idées sur la Météorologie*, Tome 2, 1787, pp. 206–7.

The italics and inverted commas are De Luc's own.

In this communication, made by Cavendish to Priestley, the theory of the composition of water is clearly indicated. The two gases—known to have been hydrogen and oxygen—were mixed together *in due proportion*, and by means of the electric spark were *entirely converted* into water. Referring to one of Cavendish's experiments, as recorded in his Journal, Lord Jeffrey, the most candid and judicious of Watt's advocates, has said, "If he (Cavendish) had even stated in the detail of it that the airs were *converted*, or *changed*, or *turned* into water it would probably have been enough to have secured to him the credit of this discovery as well as to have given the scientific world the benefit of it in the event of his death before he could prevail on his modesty to claim it in public."—*Edinburgh Review*, vol. 87, p. 125.

The evidence which this distinguished critic and judge regarded as sufficent to establish Cavendish's claim is now afforded, not by a note in his private journal, but by the testimony of the zealous friend of Watt, who states that it was communicated to Priestley towards the end of 1782, that is to say, several months before Watt drew his own conclusions from Priestley's bungling repetition of Cavendish's experiments. It was, moreover, published to the world and suffered to remain uncontradicted while all the parties were alive and in frequent intercourse with the author and with each other.

It is a remarkable fact that notwithstanding all the researches made on many occasions during the past half-century on the claim to the discovery of the composition of water, and even within the past year by eminent *savants*, the evidence published by De Luc, in 1787, remained undiscovered, with an exception, that being, as above mentioned, the late Robert Brown, Esq., and this is the more remarkable when we remember

that De Luc's chapter, already referred to, is especially devoted to anecdotes on the subject in question.

[We happen to know that this knowledge had long been in Mr. Brown's possession, at least for the last nine or ten years of his life, during which the water-controversy has been so rife, if not from the time when he furnished Cavendish's biographer with incidental information; also that he regarded it as decisive of the controversy. So remarkable a retinence in such a case is probably unparalleled, but is perfectly characteristic. It is to be hoped that Mr. Brown has left some record or indication to show how he reconciled De Luc's statement, in 1787, of what occurred in 1782 with his (De Luc's) letters to Watt in 1783–4, now published in the Watt correspondence. The only apparent solution of this new enigma, consistent with the idea of De Luc's truthfulness, is that he had at the time misunderstood Priestley's verbal communication, but had been afterwards corrected by Priestley. That the name of "Cavendish" is not a *lapsus* for that of Watt is pretty certain. So, De Luc's statement, published in 1787,—at a time when Watt and Cavendish were in personal communication—may be regarded as his own reversal of the views he had expressed in his correspondence with Watt, and even as an indication of the understanding of the parties at the time. And it is singular that its republication now should close the long controversy which followed the resuscitation of this correspondence by Arago.—Eds.]

6. *On the Electric Conducting-Power of the Metals*; by Augustus Matthiessen, Ph.D., (L. E. and D. Phil. Mag., vol. xvi, p. 219).—The following values for the conducting power of the metals were determined in the Physical Laboratory at Heidelberg, under the direction of Professor Kirchhoff, by the same method as is described in the "Philosophical Magazine," Feb. 1857.

	Conducting Power at	Temp. in Centigrade degrees.
Silver,	100	0°
Copper, No. 3,	77·43	18·8
Copper, No. 2,	72·06	22·6
Gold,	55·19	21·8
Sodium,	37·43	21·7
Aluminium,	33·76	19·6
Copper, No. 1,	30·63	24·2
Zinc,	27·39	17·6
Magnesium,	25·47	17·0
Calcium,	22·14	16·8
Cadmium,	22·10	18·8
Potassium,	20·85	20·4
Lithium,	19·00	20·0
Iron,	14·44	20·4
Palladium,	12·64	17·2
Tin,	11·45	21·0
Platinum,	10·53	20·7
Lead,	7·77	17·3
Argentine,	7·67	18·7
Strontium,	6·71	20·0
Antimony,	4·29	18·7
Mercury,	1·63	22·8
Bismuth,	1·19	13·8

Alloy of Bismuth 32 parts, Antimony 1 part,	0·884	24·0
Alloy of Bismuth 12 parts, Tin 1 part,	0·519	22·0
Alloy of Antimony 2 parts, Zinc 1 part,	0·413	25·0
Graphite, No. 1,	0·0693	22·0
Graphite, No. 2,	0·0436	22·0
Gas-coke,	0·0386	25·0
Graphite, No. 3,	0·00395	22·0
Bunsen's Battery-coke,	0·00246	26·2
Tellurium,	0·000777	19·6
Red Phosphorus,	0·00000123	24·0

All the metals were the same as those used for my thermo-electric experiments, with the exception of cadmium, which was purified by my friend Mr. B. Jegel.

The alloys of bismuth-antimony, bismuth-tin, antimony and zinc were determined in order to ascertain, whether, as they give, with other metals, such strong thermo-electric currents, they might be more advantageously employed for thermo-electric batteries than those constructed of bismuth and antimony.

Coppers No. 1, 2, 3 were wires of commerce. No. 1 contained small quantities of lead, tin, zinc, and nickel. The low conducting power of No. 1 is owing, as Prof. Bunsen thinks, to a small quantity of suboxyd being dissolved up in it.

Graphite No. 1 is the so-called pure Ceylon; No. 3 purified German, and No. 2 a mixture of both. The specimens were purified by Brodie's patent and pressed by Mr. Cartmell, to whom I am indebted for the above.

The conducting power for gas-coke, graphite, and Bunsen's battery-coke increases by heat from 0° to 140° C.; it increases for each degree 0·00245, *i. e.* at 0° C. the conducting power =100, and between the common temperature and a light red heat about 12 per cent. The following metals were chemically pure:—Silver, gold, zinc, cadmium, tin, lead, antimony, quicksilver, bismuth, tellurium. Those pressed were sodium, zinc, magnesium, calcium, cadmium, potassium, tin, lead, strontium, antimony, bismuth, tellurium, and the alloys of bismuth-antimony and bismuth-tin. The way in which these wires were made is described in the "Philosophical Magazine" for February, 1857.

II. MINERALOGY AND GEOLOGY.

1. *Note on Rammelsberg's results with regard to the Composition of the Titanic Iron Ores;* by JAMES D. DANA.—In this volume, at page 127, an abstract is given of the important researches of Prof. Rammelsberg on the titanic iron ores. One of the conclusions to which he arrives is, that they are compounds in different proportions of titanate of protoxyd of iron (FeO, TiO^2) with Fe^2O^3, in which part of the FeO is often replaced by magnesia (MgO). The proportions of the two members in different varieties are mentioned, but the numbers given are in general only approximate results from the analyses.

The great dominant fact in the titanic irons is their isomorphism with hematite, Fe^2O^3, and if we adopt Laurent's view of the constitution of such compounds, instead of looking for a titanate and sesquioxyd com-

bined, all the twelve varieties, with two or three exceptions, come very closely under the general formula M^2O^3,—M standing for all the metals (iron, titanium, manganese and magnesium) present. The following table shows that the coincidence for the varieties analyzed is quite remarkable —all but three or four giving almost exactly the ratio 1 : 1·5=2 : 3.

	M O Ratio.		M O Ratio.
Var. 1.	21·77 : 32·11=1 : 1·48	Var. 7.	20·52 : 30·80=1 : 1·50
" 2.	22·71 : 54·64=1 : 1·52	" 8.	20·29 : 30·62=1 : 1·51
" 3.	20·67 : 31·55=1 : 1·50	" 9.	20·14 : 30·29=1 : 1·50
" 4.	20·09 : 32·11=1 : 1·60	" 10.	20·07 : 30·14=1 : 1·50
" 5.	20·58 : 31·48=1 : 1·53	" 11.	20·23 : 30·44=1 : 1·50
" 6A.	21·17 : 31·67=1 : 1·50	" 12.	20·13 : 30·22=1 : 1·50
" 6B.	20·62 : 31·64=1 : 1·54		

The formula M^2O^3 appears to express the true nature of the compound.

2. *Kaba-Delreczin Meteorite.*—On the 15th of April, 1857, at 10^h P. M., a meteorite fell near Kaba in the vicinity of Delreczin in Hungary, and is now in a public Cabinet at that place. It is named the Kaba-Delreczin meteorite. Its weight before being broken was 7 pounds; but is now reduced to 5½ pounds. It has not been analyzed.

3. *Ohaba Meteorite.*—On the 10th of October, 1857, some time after midnight there was a fall of a meteorite in the commune of Ohaba, east of Carlsburg. It is pyramidal in form, 14½ inches in height, and weighs 29 pounds. Specific gravity according to Dr. Grailich, 3·1103. It contains, according to Dr. Birkeisen:

Insoluble silicate (olivine),	44·83
Soluble silicate (augite and a feldspar),	18·27
Nickeliferous iron (Fe 21·40, Ni 1·80),	23·76
Sulphuret of iron,	13·14
	100·00

The specimen is in the Hof. Mineral Cabinet of Vienna.

4. *Geological Explorations in Kansas Territory;* by F. B. Meek and F. V. Hayden, (Proc. Acad. Nat. Sci. Philad., Jan. 1859).—This paper gives the results of the most extensive explorations of the Kansas rocks that have yet been made. They were undertaken last summer by Messrs. Meek and Hayden, and were carried forward with their well-known care and ability. The paper includes details respecting the Permian and Carboniferous rocks, their order of succession and characteristic fossils, and closes with descriptions of a considerable number of species. We cite a few pages giving a general section of the series, with their remarks upon the strata.

"As our examinations along the Kansas and Smoky Hill rivers above this point were made in more detail, where the outcrops were more frequent and continuous, we have, as we believe, been able to trace out the connections and order of succession of the various strata with considerable accuracy. Hence, we give below a general section of the rocks in this region, commencing with the Cretaceous sandstones on the summits of the Smoky Hills, lat. 38° 30′ N., long. 98° W., and descending through the various intermediate formations seen along the Smoky Hill and Kansas rivers, to the base of the bluff already mentioned, opposite the mouth of Big Blue river, on the Kansas. It is true, there are a few gaps in this section, where we were unable to see the beds along some of the slopes, but as we know the position in the series, as well as the extent of these gaps, it will be easy to determine, when a greater number of exposures have been examined, the nature of the beds occupying them.

General section of the Rocks of Kansas Valley from the Cretaceous down, so as to include portions of the upper Coal measures.

Feet.

1. Red, brown, and yellowish, rather coarse-grained sandstone, often obliquely laminated, and containing many ferruginous concretions; also, fossil wood and many leaves of dicotyledonous trees, some of which belong to existing genera, and others to genera peculiar to the Cretaceous epoch. *Locality, summit of Smoky Hills*.. 60

2. Whitish, very fine grained argillaceous sandstone, underlaid by bluish purple and ash colored clays. *Locality same as preceding*.................. 15

3. Long, gentle slope, with occasional outcrops of ash-colored red, blue, and whitish, more or less laminated clays, with thin beds of sandstone. *Locality same as preceding, and extending down at places nearly or quite to the bluffs of Smoky Hill river;* thickness about.. 200

4. Red sandstone, with some layers of hard, light gray calcareous, do., and both containing ferruginous concretions. *Locality, bluffs Smoky Hill river, five or six miles above Grand Saline river.* Probably local, thickness seen about .. 15

5. Bluish, red, light yellow, and gray clays, and soft claystones, with sometimes a few thin layers of magnesian limestone. In many places these clays have been traversed in every direction by cracks, into which calcareous and argillaceous matter have found their way, and subsequently become consolidated so as to form thin seams of impure yellowish limestone, which cross and intersect each other at every angle. The red clays are usually less distinctly laminated, contain more arenaceous matter, and often show ripple marks on the surfaces. *Locality, bluffs along Smoky Hill river, above the mouth of the Grand Saline*.. 60

6. Light gray, ash-colored, and red clays, sometimes arenaceous, and often traversed by cracks, filled with calcareous matter as in the bed above,—alternating with thin layers and seams of gypsum. *Locality, near mouth of Smoky Hill river*.. 40

7. Rather compact amorphous white gypsum, with near the base disseminated crystals, dark colored do. *Locality same as last*..................4½ to 5

8. Alternations of ash-colored, more or less arenaceous clays, with thin beds and seams of gypsum above; towards lower part, thin layers of claystone, and at some places soft magnesian limestone. *Locality same as last*............ 50

9. Rough conglomerated mass, composed of fragments magnesian limestone and sandstone, with sometimes a few quartz pebbles, cemented by calcareous and arenaceous matter; variable in the thickness and probably local. *Locality, south side of Smoky Hill river, ten or twelve miles below Solomon's Fork*...seen 18

10. Bluish, light gray, and red laminated clays, with seams and beds of yellowish magnesian limestone, containing *Monotis Hawni, Myalina perattenuata, Pleurophorus? subcuneatus, Edmondia? Calhouni, Pecten* undet., and *Spirigera* near *S. subtilita;* also *Nautilus eccentricus, Bakevellia parva, Leda subscitula, Axinus rotundatus*, and undetermined species of *Bellerophon, Murchisonia, &c. Locality, near Smoky Hill river, on high country south of Fort Riley, as well as on Cottonwood creek*.. 90

11. Light grayish and yellow magnesian limestone, in layers and beds sometimes alternating with bluish and other colored clays, and containing *Solemya*, a *Myalina* near *M. squamosa, Pleurophorus? subcuneatus, Bakevellia parva, Pecten* undt., and a *Euomphalus* near *E. rugosus;* also, a *Spirigera* allied to *S. subtilita*, but more gibbous, *Orthisina umbraculum? O. Shumardiana, &c. Locality, summit of the hills, near Fort Riley and above there; also seen on Cottonwood creek*..25 to 35

12. Light grayish yellow, rather granular magnesian limestone, containing spines and plates of *Archæocidaris;* a few fragments of small *Crinoid* columns, *Spirifer* similar to *S. lineatus*, but perhaps distinct; also same *Spirigera* seen in beds above, *Orthisina Shumardiana, O. umbraculum?* and *Productus Calhounianus. Forms distinct horizon near summit of hills in vicinity of Fort Riley, also seen on Cottonwood creek*..7 to 8

13. Soft argillo-calcareous beds, apparently local. *Kansas Falls*......... 5

Feet.

14. Light grayish and yellowish magnesian limestone, containing many concretions of flint, also the same *Spirigera* found in beds above, and *Productus Norwoodi*, *P. Calhounianus*, with *Discina tenuilineata*, and an undetermined *Monotis*. *Fort Riley and below; also at Kansas Falls and on Cottonwood creek.* 38

15. Alternations, bluish, yellowish and brown clays, with a few thin seams of limestone. *Fort Riley, Kansas Falls; also below Fort Riley, and on Cottonwood creek*.. 35

16. Light yellowish magnesian limestone, containing *fucoidal* markings, fragments of small *Crinoid* columns, *Pecten*, *Allorisma*, *Spirigera*, *Orthisina umbraculum?* *O. Shumardiana*, *Discina tenuilineata*, &c. *Lower quarry at Fort Riley, and at other places above and below Fort R., as well as on Cottonwood creek*..4 to

17. Alternations of blue, red, and light gray clays, with sometimes thin layers and seams of magnesian limestone. *Fort Riley*..................... 28

18. Light gray and whitish magnesian limestone containing *Spirigera*, *Orthisina umbraculum?* *O. Shumardiana*, *Productus Calhounianus*, *Acanthocladia Americana*, and undt. *sp.* *Cyathocrinus*. Lower part containing many concretions of flint. *Fort Riley and on Cottonwood creek.* Whole thickness about.. 40

19. Brown, green, and very light gray clays, alternating; contains near the upper part fragments of *Crinoid* columns, *Synocladia biserialis*, *spirigera*, *Productus Norwoodi*, *Chonetes mucronata*, *Orthisina Shumardiana*, *Orthisina umbraculum*, &c., with teeth of *Petalodus Alleghaniensis*. *Fort Riley*.......... 14

20. Alternations of rather thin layers light yellowish magnesian limestone, and various colored clays; the limestone layers containing *Monotis*, *Synocladia biserialis*, &c. *Locality same as last*........................... 33

21. Slope, no rocks seen. *Below Fort Riley*.............................. 25

22. Whitish, or very light gray magnesian limestone, rendered porous by cavities left by the weathering out of numerous *Fusulina*. This is the highest horizon at which any remains of *Fusulina* were met with. *Some four miles below Fort Riley, along a creek on the south side of the Kansas, and apparently not more than ten feet above it*.. 2

23. Bluish, light gray, and brown clays, with occasional layers of magnesian limestone. *Chonetes mucronata*, *Orthisina umbraculum?* *Monotis*, *Fusulina*, &c. *Ten miles below Fort Riley*.. 35

24. Hard, very light yellowish gray magnesian limestone, with *Fusulina*, and spines of *Archæocidaris*. Forms a marked horizon near the *same locality as last.* 6

25. Slope, with occasional exposures, thin layers of *Fusulina* limestone, and seams of gray limestone containing *Myalina*, *Monotis*, *Pecten*, and fragments of *Synocladia biserialis*. *Near same locality as last*................ 36

26. Light gray argillaceous limestone, showing on weathered surfaces a somewhat laminated structure; contains large spines of *Archæocidaris*. *Near Ogden Ferry, and Manhattan*... 9

27. Gray limestone, often fragmentary, with much clay above; lower part hard, and more or less cellular in middle. *Locality, same as last*............ 5

28. Whitish clays and claystones, with a thin layer of hard compact gray limestone near the middle. *Locality same as last*.......................... 10

29. Light greenish indurated clays. *Same locality*........................ 3

30. Hard, heavy bedded, white argillaceous limestone, containing *Monotis* and *Avicula*. *Ogden Ferry, and below there*............................. 5

31. Very thinly laminated dark green shale. *Three miles nearly east of Ogden Ferry, on McDowell's creek; also at Manhattan, on the Kansas*.......... 1

32. Light greenish and flesh-colored hard argillaceous limestone, with *Spirifer cameratus*. This is the highest horizon at which we found this species. *Same localities*.. 3

33. Alternations of bluish, green and red more or less calcareous laminated clays, light gray limestones and claystones, with *Pecten*, *Monotis*, and fragments of *Crinoid* columns. *Same localities*........................... 30

34. Alternations bluish, purple, and ash colored calcareous clays, passing at places into claystones, and containing in a thin bed near the middle, *Spirifer planoconvexa*, *Spirigera subtilita*, *Productus splendens?* *Rhynchonella Uta*, &c. *Locality same as preceding*.. 13

Feet.

35. Blue, light gray, and greenish clays, with occasional harder seams and layers of claystone and limestone. *Same locality*.......................... 33

36. Somewhat laminated claystone of light gray color, with more or less calc spar near lower part. *Manhattan*...................................... 19

37. Alternations of dark gray and blue, soft decomposing argillaceous limestone, with dark laminated clays, or soft shale, containing great quantities of *Fusulina cylindrica*, *F. cylindrica* var. *ventricosa*, *Discina Manhattanensis*, *Chaetetes*, and fragments *Crinoids*; also, *Chonetes Verneuiliana*, *C. mucronata*, *Productus splendens?* *Retzia Mormonii*, *Rhynchonella Uta*, *Spirigera subtilita*, *Spirifer cameratus*, *S. planoconvexus*, *Euomphalus* near *E. rugosus*, and *Synocladia biserialis*; also *Cladodus occidentalis*. *Locality, same as last*............ 13

38. Soft bluish shale, with yellow laminated arenaceous seams below, containing fucoidal markings. *Same locality*................................ 25

39. Two layers gray argillo-calcareous rock, separated by two feet of dark green and ash-colored clays. The calcareous beds contain fragments of *Crinoids*, *Chonetes*, and *Myalina* in undt. species. *Same locality as last*......... 4½

40. Light greenish, yellow, and gray clays and claystones, extending down nearly to high water mark of the Kansas, *opposite the mouth of Blue River*... 27

The foregoing general section of the strata seen along the valley of Kansas and Smoky Hill rivers, from the mouth of Blue river to the 98th degree of west longitude, is presented in its present form more with a view of illustrating the vertical range of the organic remains found in these rocks, than as an attempt to group the beds into formations that may be expected to preserve their distinctive lithological characters throughout areas of any great extent. As this has necessarily been done from a knowledge of only a portion of the fossils characterizing these strata, it is quite probable, when more extensive collections are obtained, that it may be found necessary even on this principle, to classify and group the beds somewhat differently. We are also aware that some of these beds probably increase or diminish greatly in thickness, or may even entirely thin out, at no very great distances from the localities where we saw them. * * *

It will be observed we have in this general section, without attempting to draw lines between the systems or great primary divisions, presented in regular succession the various beds with the fossils found in each, from the Cretaceous sandstone on the summits of the Smoky Hills, down through several hundred feet of intermediate doubtful strata, so as to include the beds containing Permian types of fossils, and a considerable thickness of rocks in which we find great numbers of upper coal-measure forms. We have preferred te give the section in this form because, in the first place, the upper coal measures of this region pass by so imperceptible gradations into the Permian above, that it is very difficult to determine, with our present information, at what particular horizon we should draw the line between them, while on the other hand, it is equally difficult to define the limits between the Permian and beds above, in which we found no fossils.

Beginning near the base of this section, we find we have in great numbers the following well known and widely distributed coal-measure fossils, viz., *Fusulina cylindrica*,* *Chonetes Verneuiliana*, *Productus splen-*

* In Russia, *Fusulina cylindrica* is said to occur only in the upper part of the lower Carboniferous series; but the fossil generally referred to that species in this country, appears to be confined to the coal measures. We have some doubts in regard to the identity with the Russian species.

dens, (or a closely allied species,) *Retzia Mormonii*, *Rhynchonella Uta*, *Spirigera subtilita*, *Spirifer cameratus*, *S. planoconvexus*, and a *Euomphalus* similar to *E. rugosus* of the coal measures, while the few new and undetermined species associated with these, are, for the most part, also decidedly more nearly allied to Carboniferous than Permian forms. We should here remark, however, that we occasionally met with a species of *Monotis*, allied to the Permian species *M. speluncaria* and *Synocladia biserialis*, (also regarded in the old world as a Permian genus,) at horizons far beneath the base of this section, between Manhattan and the Missouri. We even found a single specimen of this *Monotis* as low down as bed No. 9, of the section taken near the landing at Leavenworth City, which must occupy a position several hundred feet below the lowest beds of the above section. Still as this shell is very rare in the lower rocks, and the *Synocladia* is a distinct species from the well known Permian form of the old world, while they are both, at these horizons, associated with great numbers of the common well-known coal-measure species, we can only regard their presence in these beds as establishing the existence of these genera at an earlier period in this country, than in the old world. This, it seems to us, is more philosophical than it would be to place all this great thickness of strata, with their vast numbers of well known coal-measure species, in the Permian, merely because we also find with these occasionally a few forms which would in the old world be regarded as characteristic of the Permian epoch.

Taking it for granted then, that we have carried this section down far enough to include, not only all the beds containing almost exclusively Permian forms, but a considerable portion of the upper coal measures, it will be interesting to notice, as we ascend in the series, how far each of the coal-measure species mentioned in the lower part of the section, as well as of a few others that occur above and below, range upwards. Thus we see that *Fusulina cylindrica* var. *ventricosa*, *Chonetes Verneuiliana*, and *Retzia Mormonii* were not met with above division No. 37; while *Spirifer planoconvexus*, *Productus splendens?* and *Rhynchonella Uta*, were not observed above 34, nor *Spirifer cameratus* above 32. *Fusulina cylindrica*, of the slender variety so common in the coal measures of Kansas and Missouri, was not seen above 22; nor was any species or variety of that genus observed above this horizon.

Apparently the same species of *Monotis*, mentioned at various horizons far beneath, were occasionally met with in 30, 25, 23, and 20, generally associated with the same species of *Synocladia*, ranging far down into the upper coal measures. In division No. 19, we again met with the *Synocladia biserialis*, and a *Spirigera* allied to *S. subtilita*, if not identical, along with a new species of *Chonetes* we have called *C. mucronata*, which ranges down into the beds near the base of the section. Along with these were also *Productus Norwoodi* and *Orthisina Shumardiana*, both of which are common in the coal measures far below, and a large *Orthisina* similar to *O. umbraculum*, but apparently more finely striate.

Ascending through the intermediate beds to No. 12, we continue to meet with nearly all the species mentioned in 19, with the exception of *Chonetes mucronata*. We also have, first in 18, a large species of *Pro-*

ductus called *P. Calhounianus* by Professor Swallow; very similar to some varieties of *P. semireticulatus*, but thought by Prof. S., to present well marked internal differences. There is likewise added in 16, a large *Allorisma* and a *Spiriger* similar to *S. subtilita*, but much more gibbous; and in 14, *Discinia tenuilineatus* together with apparently the same *Monotis*, so often mentioned below. In 12, we also have added a small *Spirifer* similar to *S. lineatus*, but perhaps more nearly allied to the Permian species *Martinia Clannyana*, King.

The succeeding bed above, No. 11, appears also to contain a mingling of Permian with coal-measure forms, for we have in it the following Permian types, viz., *Myalina* very similar to *M. squamosa*, *Pleurophorus? subcuneatus*, *Bakevellia parva* and *Monotis Hawni*, along with a *Euomphalus* near *E. rugosus*, the same gibbous *Spirigera*, similar to *S. subtilita*, *Orthisina umbraculum?* and *O. Shumardiana*.

On passing into the next division above, No. 10, we find we have lost sight of all the characteristic Carboniferous forms, unless the *Spirigera* mentioned in some of the beds below be regarded as only a variety of *S. subtilita*, from which however, we think it specifically distinct; for with this exception, nearly all the fossils seen by us in this division, are such as would be regarded as Permian types. Although the number of *species* found by us in No. 10 is not great, *individual* specimens are often numerous. Above this horizon we saw no more fossils through a great thickness of various colored clays, claystones, &c., until ascending to the Cretaceous sandstones crowning Smoky Hills.

If we do not admit the existence in this region of an intermediate group of rocks, connecting by slight gradations the Permian above, with the coal measures below, and must draw a line somewhere, below which all is to be regarded as Carboniferous, and all above as Permian, we should certainly, upon palæontological principles alone, carry this line up as far as the top of division No. 11. The passage from the Carboniferous to the strata containing Permian types, however, is so gradual here, that it seems to us no one, undertaking to classify these rocks without any knowledge of the classification adopted in the old world, would have separated them into distinct *systems*, either upon lithological or palæontological grounds, especially as they are not, so far as our knowledge extends, separated by any discordance of stratification, or other physical break.* Indeed the fact that some of the Permian types occurring in No. 10, were first introduced in beds below this, containing many Carboniferous species, would seem to indicate that even No. 10 may possibly have been deposited just before the close of a period of transition from the conditions of the Carboniferous, to those of the Permian epoch.

"The apparent absence of fossils in the beds above No. 10, renders it impossible, with our present information, to determine with certainty the upper limits of the series containing Permian forms. It is true, there is

* We have been informed by Dr. J. G. Norwood, former State Geologist of Illinois, that the rocks in that State, referred by him and others to the same epoch as the Kansas Permian beds, rest unconformably upon the Coal measures. This, however, would be impossible in Kansas, since no disturbance of the strata occurred there, until after the close of the Cretaceous era, which would of course, not only cause the Cretaceous and Carboniferous, but all the intermediate beds, to dip at the same angle.

at places a kind of conglomerated mass, occupying the horizon No. 9, which might appear to form a natural line of division between the beds containing the Permian fossils, and those above, in which we found no organic remains; but this seems to be local, and although there is a new feature presented by the zone of gypsum deposits above it, we find between the beds and layers of gypsum, and far above the horizon at which they occur, bluish, greenish, and other colored clays, not only similar to those between the beds and layers of limestone containing the Permian fossils in division No. 10, but also precisely like the laminated clays between the beds of limestone of the upper Carboniferous series far below. Again, in these clays of the gypsum zone, as well as through a considerable thickness of clays above it, there are occasional seams of claystone, which sometimes pass into seams of magnesian limestone, exactly like some of those containing Permian fossils, in division No. 10. We saw no fossils in these seams amongst the gypsum-bearing beds, nor higher in the series, but it is probable they may yet be found in some of the more calcareous portions.

Another fact apparently indicating some kind of relation between the gypsum-bearing beds, as well as some of the higher deposits, and the rocks below, is, that we often find both in the clays between the beds of gypsum, and those between the limestone containing the Permian fossils, the same peculiar appearance caused by the cracking of the clays and subsequent infiltration of calcareous matter, seen in division No. 5. At some places the thin plates of limestone formed by the impure calcareous matter filling these cracks, may be seen ramifying through some rather thin beds of these clays in all directions, so as to cross and intersect each other at every angle. Where beds of this kind have been exposed for any length of time along near the tops of bluffs, the softer clays filling the interstices, often weather out, so as to leave a curious cellular mass, with the numerous angular cavities.

From these facts we are inclined to suspect,—though we are fully aware that it is a question which can only be determined upon evidence derived from organic remains,—that not only the gypsum-bearing deposits, but a large portion, if not all, of division No. 5, belongs to the same epoch as the beds containing the Permian fossils below.

Between No. 5 and the Cretaceous above, there is still a rather extensive series of beds in which we found no organic remains; these may be Jurassic or Triassic, or both, though as we have elsewhere suggested, we rather incline to the opinion that they may prove to belong to the former. As we have fully discussed the question in regard to the Cretaceous age of the highest division of the foregoing section in a paper read before the Academy in December last, and in an article in the American Journal of Science, January, 1859, it is unnecessary for us to add anything further on that subject here.

As already stated, our observations along the Kansas valley, to within twelve or fourteen miles of the mouth of Big Blue river, were too isolated to determine in all cases the relations between outcrops seen at different places. Consequently, although we saw at several points along this part of the valley, indications of a westward or northwestward inclination of the strata, we were left in some doubt whether or not there is

a general inclination of the rocks in that direction, between Wabounse and the Missouri. Above this point, however, our observations being more connected, and the exposures more continuous, we were able to determine very satisfactorily that there is at least from near Wabounse, a uniform dip towards the west or northwest, so that in ascending the Kansas valley from this region, we are constantly meeting with more and more modern rocks, as those we leave behind pass beneath the level of Kansas. * * * *

From the foregoing statements it will be seen that in consequence of the dip of the strata to the northwest, and in some slight degree to the fall of the Kansas and Smoky Hill rivers, the whole of the foregoing general section below No. 12 passes beneath the level of the Smoky Hill, between the mouth of Blue river and Chapman's Creek. Consequently, the limestones of the succeeding beds above being thinner and less durable than those below, and separated by heavy beds of clay; we find, as might be expected, that the country here in the region of the mouth of Chapman's Creek, is much lower than at Fort Riley and below.

On reaching the mouth of Solomon's Fork, we found the face of the country characterized by long gentle grassy slopes, no part of it near the river apparently being elevated more than about 60 or 70 feet above its surface. A short distance beyond this, we caught the first glimpse of the Smoky Hills, which were seen in a direction a little south of west from us, rising above the surrounding low country like dark blue clouds above the horizon. On approaching these, we found them always situated several miles back from the river, and rising some three hundred and fifty feet above it. The immediate bluffs of the river here, are generally composed of divisions No. 4 and 5 of the foregoing general section, and that portion of these hills above the level of the summits of the bluffs along the river, is made up of division Nos. 3, 2, 1, of the same section. On the south side of the river these hills have but a comparatively thin capping of the sandstone No. 1, but on the north side we saw it showing a thickening on some of them of sixty feet.

From some of these hills on the north side of Smoky Hill river, between it and the Grand Saline, we had an extensive and beautiful view of the surrounding country. In the north and northwest, many similar hills were in sight, and as the dip of the strata here is in that direction, it is probable that some of this are not only chiefly made up of the sandstone No. 1, but surmounted by the other Cretaceous beds Nos. 2 and 3 of the Nebraska Cretaceous series; indeed, Dr. Engelmann found all these formations occupying this relation on Republican river, not more than seventy miles north of this.*

Although this paper is merely designed to give a brief sketch of the leading geological features of these portions of northeastern Kansas visited by us, we cannot close it without alluding to the truly great agricultural and other natural resources of this new and interesting territory. We mean no disparagement to other portions of the Mississippi valley, when we state, that after having travelled extensively in the Great West, and after having seen many of its most favored spots, we have met with no country combining more attractive features than Kansas Territory. Her

* See Report of Secretary of War, Dec. 5th, 1857, page 497.

geographical position gives her a comparatively mild and genial climate, intermediate between the extremes of heat and cold, while the rich virgin soil of her beautiful prairies is admirably adapted to the growth of all the great staple grain and root crops of the west.

It is true that in some districts there is rather a deficiency of timber, but as a general thing there is along the streams sufficient for the immediate wants of the country. In addition to this, the wonderful rapidity with which forests are known to have sprung up on similar prairie lands in Missouri, as the country became settled so as to keep out the annual fires, shows that the present scarcity of timber should not be regarded as presenting any serious obstable to the settlement of the most extensive prairie district in Kansas.

Before going out into the interior of the Territory, we had expected to find the whole country immediately west of Fort Riley comparatively sterile; on the contrary, however, we were agreeably disappointed at meeting with scarcely any indications of decreasing fertility as far as our travels extended, which was about sixty miles west of Fort Riley. Here we found the prairies clothed with a luxuriant growth of grass, and literally alive with vast herds of buffalo that were seen quietly grazing as far as the eye could reach in every direction. Even on the high divide between the Smoky Hill and Arkansas rivers, south of this, we found the soil rich and supporting a dense growth of grass; and from all we could learn from persons who have gone further out, the same kind of country extends for a long distance beyond this, towards the west. Hence we infer that the belt of unproductive lands between the rich country on the east, and the eastern base of the Rocky Mountains on the west, is much narrower than is generally supposed; and even this so-called desert country is known to possess a good soil, which may be rendered fruitful by artificial irrigation.

In regard to the mineral resources of Kansas, we have at present only time and space to say a few words. As already stated, coal is known to exist, though its extent is not yet fully determined, at several localities in the region of Leavenworth City, while the geological structure of the country, as well as discoveries already made, warrant the conclusion that this important and useful mineral abounds at many localities south of there. Limestone suitable for building purposes, and the production of quicklime, exist throughout large areas, while inexhaustible beds of gypsum are known to occur at several places not far west of the mouth of Solomon's river. Near this place we likewise saw in the lower Cretaceous rocks crowning the summits of the Smoky Hills, deposits of iron ore, but were unable to determine in the limited time at our command, whether or not it exists in large quantities."

5. *On the Tertiary Flora of the vicinity of Vienna;* by Dr. C. von Ettingshausen, (Abhandl. der k. k. Geol. Reichs. Wien, vol. ii).—This paper contains descriptions of 33 species which are illustrated by figures on five 4to plates. The principal conclusions from the facts are these:

The Flora belongs to the Miocene period. It is closely analogous to that of the Miocene deposits of Upper Styria at Parschlug and Fohnsdorf, Leoben, etc. It is also near that of Swoszowice in Galicia, and has some relations to that of Bilin in Bohemia, and of Œningen, and St. Gallen in Switzerland.

Among the species 1 of them has a representative in Central Europe, 4 in Southern Europe, 2 in Central Asia, 10 in North America, 2 in South America, 6 in the East Indies, and 2 in Australia.

The Climate indicated is subtropical or from 15° *to* 21° *R.*

The especially tropical species are *Artocarpidium cecropiæfolium*, *Daphnogene polymorpha*, *Cissus platanifolia*, *Sterculia Vindobonensis*, *Pterospermum dubium*, *Cupanodes miocenicus.* = 6.

The subtropical are *Laurus Swoszowiciana*, *Hakea pseudo-nitida*, *Dryandra Vindobonensis* (the last two Australian in type), *Bumelia ambigua*, *Diospyros pannonica*, *Andromedites paradoxus*, *Rhamnus Augustinii*, *Myrtus Austriaca*, *Leguminosites macharioides*, *L. ingæfolius*, *Cassia ambigua.* = 11.

The warm temperate species are *Cyperites tertiarius*, *Potamogeton Ungeri*, *Pinites Partschii*, *Betula prisca*, *B. Brongniartii*, *Alnus Kefersteinii*, *Fagus castaneæfolia*, *Quercus Haidingeri*, *Planera Ungeri*, *Liquidambar europæum*, *Styrax pristinum*, *Acer pseudocreticum*, *Pterocarya Haidingeri.* = 13.

The species particularly North American in type are *Fagus castaneæfolia*, *Quercus Haidingeri*, *Liquidambar europæum*, *Laurus Swoszowiciana*, *Bumelia ambigua*, *Diospyros pannonica*, *Andromedites paradoxus.*

These beds contain *Hippotherium gracile* Kaup, among remains of Mammals; *Cybium Partschii* Münst., among Fishes; *Melanopis Martiniana* Fér., *M. Bouei* Fér., *M. pygmæa* Partsch, *Cardium apertum* Munst., *C. plicatum* Eichw., *Congeria subglobosa* Partsch., *C. spathulata* Partsch, among Molluscs; *Cytherina tenuis* Reuss among Crustacea.

6. *On the Tertiary Flora of Haring in the Tyrol;* by Dr. C. von Ettingshausen.—This paper is finely illustrated like the preceding. It describes 180 species.

The Flora is of the Eocene Period; of the same age with that of Sotzka in Upper Styria, Sagor in Krain, Monte Cromina in Dalmatia. 73 of the species have been described from other localities, and of these 41 are exclusively Eocene, 9 Miocene, and 23 common to Eocene and Miocene. Among the Miocene localities. that of Parschlug contains the largest number of the Haring species, namely 21; Oeningen contains 8, Bonn 7, Bilin 7, Vienna 3 and Heiligenkreuz near Kremnitz 2 identical species.

The Climate indicated by the plants is tropical or a mean temperature between 18 *and* 22° *R.*

There are several species of palms, and representatives of the families Moreæ, Artocarpeæ, Nyctagineæ, Monimiaceæ Laurineæ, Proteaceæ, Apocynaceæ, Bignoniaceæ, Sapotaceæ, Ericaceæ, Malpighiaceæ, Sapindaceæ, Euphorbiaceæ, Rhizophoreæ, Myrtaceæ, Papilionaceæ, Mimoseæ, etc.

The Flora has its closest analogies with that of Australia.—The Proteaceæ, Myrtaceæ, and Leguminoceæ constitute a third part of the flora. 55 species out of the whole are analogous to Australian types, 28 to East Indian, 23 to tropical America, 14 to South African, 8 to Pacific Island, 7 to North American and Mexican, 6 West Indian, 5 South European. The resemblance to Australia consists not merely in the number of the species, but also in the characters of the species—as the small oblong leathery leaves of the Proteaceæ and Myrtaceæ, the delicate branchlets of the Casuarinæ, the Cypress-like Australian species of *Frenela*

and *Callitris*, some peculiar species of Santalaceæ, Sapotaceæ, and Leguminoseæ. This relation to Australian vegetation is also evident in the fossil flora of Sotzka. Only 11 species have their representatives in the warm temperate climates, namely, *Juniperites eocenica*, *Pinites Palæostrobus*, *Quercus deformis*, *Q. Goepperti*, *Alnites Reussii*, *Planera Ungeri*, *Salicites stenophyllos*, *Laurus Lalages*, *Ilex Oreadum*, *Rhamnus colubrinoides*, *Juglans hydrophila*.

7. *Fossil Flora of Köflach, near Gratz, in Styria.*—Dr. C. R. von Ettingshausen has described the plants of Köflach in the Jahrbuch der k. k. geol. Reichsanstalt of Vienna, 1857, p. 738. They are of the Miocene era. There are 34 species, 12 of which are new, and 15 common with the flora of Fohnsdorf in Styria. More of the species occur in the Miocene of Switzerland than in the fossil flora of Schauerleithen near Pitten in Lower Austria, and but very few of them are found in the Parschlug deposit. The most common species are the *Sequoia Langsdorfi* Heer, and *Alnus Kefersteinii* Goepp.; and next to these *Glyptostrobus Europæus* Heer, *Betula Brongniartii* Ettings., and *Carpinus Heerii*. Among the peculiar species there is a *Myrica Joannis* Ettings., near the *Myrica Caroliniana* of North America, *Verbenophyllum aculeatum* Ettings., *Dombeyopsis helicteroides* Ettings., a tropical American type, *Euonymus Haidingeri* Ett., *Zizyphus Daphnogenes*, *Ceanothus macrophyllus* Ett., also related to a North American type, *Euphorbiophyllum crassinerve* and *E. Stiriacum* Ett., analogues of tropical Euphorbiaceæ. The paper is illustrated by many excellent wood-cuts and three plates.

8. *On some deposits in Tuscany containing Fossil Leaves;* by C. T. Gaudin of Lausanne, and Marquis C. Strozzi of Florence.—According to a notice in the Jahresb. k. k. Geol. Reichs. 1858, p. 135, these Tuscan deposits are situated in the upper part of the valley of the Arno, at Montajone, Bozzone and Malmerenda. These and the Piedmont beds of Chieri, Guarena, Sarzanello and others, and those of Sinigaglia, are on nearly the same horizon with those of Parschlug, Tallya, Swoszowice, Gleichenberg, Schossnitz, and also the Swiss localities at Oeningen, Ischel, Schrotzburg, Albis, Locle and the upper freshwater mollasse, while of older tertiary (Eocene above the nummulitic beds), are the deposits of Cadibona, Bagnasco, Stella in Italy; Lausanne, Aarwangen, Moulin-Monod, Hohe-Rhonen, Eriz, Rochette, Rivaz, Ralligen, Wäggis, in Switzerland; and Häring, Sotzka, Monte Promina of Austria.

9. *Post-tertiary of the St. Lawrence Valley;* by J. W. Dawson, (Canadian Nat. and Geol., iv, 23).—This paper describes and figures a number of new species of Foraminifers and Bryozoans from the Canada Post-tertiary, besides giving details respecting two or three localities, mentioned in the former paper, (see this Journal, [2], xxv, 275, and Can. Nat. and Geol. ii, 401). The following paragraphs are cited from the memoir.

Section at *Logan's Farm:*

Soil and Sand, - - - - - - - - - -	1	9
Tough reddish clay, - - - - - - - - - -	0	0¼
Gray sand, a few specimens of *Saxicava rugosa*, *Mytilus edulis*, *Tellina Grœnlandica*, and *Mya arenaria*, the valves generally united, - - - - - - - - - -	0	8

Tough reddish clay, a few shells of *Astarte Laurentiana*, and *Leda Portlandica*, - - - - - - - -	1	1
Gray sand, containing detached valves of *Saxicava rugosa*, *Mya truncata*, and *Tellina Grœnlandica*; also *Trichotropis borealis*, and *Balanus crenatus*: the shells in three thin layers, - - - - - - - - - - -	0	8
Sand and clay, with a few shells, principally *Saxicava* in detached valves, - - - - - - - - -	1	3
Band of sandy clay, full of *Natica clausa*, *Trichotropis borealis*, *Fusus tornatus*, *Buccinnum undatum*, *Astarte Laurentiana*, *Balanus crenatus*, &c. &c., sponges and *Foraminifera*. Nearly all the rare and deep-sea shells of this locality occur in this band, - - - - - - - - - -	0	3
Sand and clay, a few shells of *Astarte* and *Saxicava*, and remains of sea-weeds with *Lepralia* attached; also *Foraminifera*, - - - - - - - - - - -	2	0
Stony clay, boulder clay.		

It thus appears that at Logan's farm we have littoral species at top, and that all the rare and deep-water fossils, as well as the *Lepraliæ* and *Foraminifera* occur in a comparatively thin band near the base of the deposit. This corresponds precisely with the order observed elsewhere in the vicinity of Montreal; though at Logan's farm the arrangement is somewhat more complex than in other localities.

Beauport.—I visited this celebrated deposit for the first time last autumn. At first sight it consists of a mass of stratified sand and gravel, equivalent to the Saxicava sand of Montreal, and resting on boulder clay. The overlying mass is filled with *Saxicava*, *Tellinæ*, &c.; and the underlying boulder clay as usual contains no fossils. My experience in the Montreal deposits, however, led me to expect a bed, however thin, representing the Leda clay, between these; and on searching at the junction of the two great beds above mentioned, I was gratified by finding a layer of sand about three inches in thickness, filled with the rarer shells of the deposit, characteristic of its deeper waters, such as *Fusus tornatus*, *Pecten Islandicus*, *Buccinum ciliatum*, *Modiolaria discors*, &c.* The *Rhynconella psittacea* occurs only in this layer, and in such a manner as to leave no doubt that it is buried here in situ, in the very spot where it lay anchored to the stones of the surface of the drift. On these stones, however, I found a new and interesting field for observation. In the thin layer above referred to, all the stones, as well as those that lay on the surface of the boulder clay or partly imbedded in it, were covered with the remains of marine creatures, especially *Balanus crenatus*, *Spirorbis sinistrorsa*, *Spirorbis spirillum*, *Lepralia* and *Hippothoa*. This layer, in short, evidently represented a time when the surface of the boulder clay, covered only by a thin layer of sand and stones, constituted the bottom of clear and deep water, before it became covered by the Saxicava sand. This bottom, although no clay has been deposited on it, represents the Leda clay at Montreal, and is exceedingly rich in the fossils usually found

* Sir C. Lyell notices the fact that these shells are more abundant in the lower part of the mass than above.

at the surface of that bed. *Foraminifera* occur in it, but they are comparatively rare, and, so far as I could find, only of species common at Montreal.

The paper concludes as follows:

"In so far as general conclusions in geology are concerned, the observations of the past year do not in any way conflict with the conclusions stated in my former paper.

The arrangement of the deposits at Logan's farm and Beauport, confirms the subdivision which I have attempted to establish, of an underlying non-fossiliferous boulder clay, a deep-water bed of clay or sand (the Leda clay of Montreal), and overlying shallow-water sands and gravels, the Saxicava sand of my former paper. This arrangement shows a gradual upheaval of the land from its state of depression in the boulder-clay period, corresponding with what has been deduced from similar appearances in the Old World. 'The upheaval of the bed of the glacial sea,' says Forbes, 'was not sudden but gradual. The phenomena so well described by Prof. Forchhammer in his essays on the Danish drift, indicating a conversion of a muddy sea of some depth into one choked up with sand banks, are, though not universal, equally evident in the British Isles, especially in Ireland and the Isle of Man.'*

We now have in all, exclusive of doubtful forms, sixty-three species of Marine Invertebrates from the Post-Pliocene or Pleistocene clays of the St. Lawrence valley. All, except four or five species belonging to the older or deep-water part of the deposit, are known as living shells of the Arctic or Boreal regions of the Atlantic. About half of the species are fossil in the Pleistocene of Great Britain. A majority of the whole are now living in the Gulf of St. Lawrence and on the neighboring coasts; and I have reason to believe that the dredging operations carried on by the officers of the Geological Survey in the past summer, will enable us to recognize all but a few as living Canadian species. In so far, then, as marine life is concerned, the modern period in this country is connected with that of the boulder clay by an unbroken chain of animal existence. These deposits in Lower Canada afford no indications of the terrestrial fauna; but the remains of *Elephas Primigenius* in beds of similar age in Upper Canada,† show that during the period in question great changes occurred among the animals of the land; and we may hope to find similar evidences in Lower Canada, especially in localities where, as on the Ottawa, the debris of land-plants and land-shells occur in the marine deposits."

10. *Second Biennial Report on the Geology of Alabama;* by M. Tuomey, A.M., Geologist to the State, and Prof. Geol. and Nat. Hist. Univ. of Alabama; edited from the Author's MSS. and other papers by J. W. Mallet, Ph.D., Prof. Chem. Univ. of Alabama.—The death of Prof. Tuomey left the Geological Survey of Alabama, that had been in progress under his charge, unfinished, and the preparation of his Second Report incomplete. A large part of the MS. was given to the printers in 1856; but only one or two signatures had been printed before his decease in March, 1857. The manuscript, partly in confusion and partly lost through some carelessness on the part of the printer, was afterwards put into the hands of

* Memoirs of Geological Survey. † Reports of Geol. Survey; Lyell's Travels.

Prof. Mallet, the Chemist of the Survey, and under his direction the results have been brought out. The volume treats briefly of the geology of the northern part of the State, giving some facts relating to the Silurian, Devonian and Carboniferous rocks, and also the metamorphic, with particular descriptions of iron ores and other economical products. It also mentions local details on the newer deposits of the State. The important statement is here made that the "*Gnathodon* beds" of Mobile bay, regarded as fossil beds by Lyell, are beyond doubt accumulations made by the aborigines of the country. They are often in heaps and contain ashes, burnt shells and charcoal, and bear no evidence of accumulation by wave action. The Report of Prof. Mallet, as Chemist of the Survey, contains analyses of a large number of rocks and ores.

11. *The Earthquake Catalogue of the British Association*, with the Discussions, Curves and Maps, etc.; by ROBERT MALLET, C.E., F.R.S., and JOHN WILLIAM MALLET, Ph.D., Prof. Chem. University of Alabama. From the Transactions of the British Association for the Advancement of Science, 1852 to 1858: being Third and Fourth Reports. Lond. 1858.—This thick 8vo volume contains the papers of the authors on earthquakes contributed to the British Association at the meetings from 1852 to 1858; of their thoroughness and great value it is not necessary here to speak. The work is indispensable to all who would understand the subject in its details and full breadth. The paper of 1858 is now for the first time issued, as the Report of the Association for last year has not yet been distributed: and it has special interest as it reviews the "Facts and Theories of Earthquake phenomena," and is illustrated by several fine maps.

12. *Catalogue of Mineralogical, Geological and Palæontological Specimens, Collections, Models, etc., offered for sale at the Rheinische Mineralien-Comptoir of Dr. A. Krantz, at Bonn in Prussia.* American edition, 1859, pp. 48.—Collectors of mineral and geological specimens will be glad to know that Dr. Krantz has published an American edition of his Catalogue, and that it may be obtained gratis on application to Messrs. J. F. Luhme & Co., who have been appointed his sole agents for the United States. This Catalogue will serve an excellent purpose in guiding mineralogists and others as to the comparative value of mineral and geological specimens, and at the same time it gives an idea of the extended scale upon which Dr. Krantz conducts business in his justly celebrated establishment.

III. BOTANY AND ZOOLOGY.

1. *American Weeds and Useful Plants: being a second and illustrated edition of Agricultural Botany, &c.*; by WM. DARLINGTON, M.D. Revised, with additions, by GEORGE THURBER, Prof. of Mat. Med. and Bot. in N. Y. College of Pharmacy. New York: Moore & Co. 1859, pp. 460, 18mo.—Dr. Darlington's Agricultural Botany was always a favorite, and in its new dress it deserves to be still more so. While regretting that the author, at his advanced age, "felt indisposed to assume the labor of a revision," we are satisfied that, if the task must fall into younger hands, it could hardly fall into better ones than those of the present editor.

He has extended the limits of the work so as to include the commoner medicinal plants, and such of our native shrubs as are worthy of cultivation, and has added a brief, remarkably well written, and pertinent introductory chapter upon the Structure of Plants, followed by a key to the natural orders of the plants described in the volume. In a book so full of information about useful plants, it seems hardly fair to promote the term 'weeds' to the head of the title—by these meaning "those intrusive and unwelcome individuals that will persist in growing where they are not wanted." But, after all, so far as botany can help him, the farmer needs rather to be instructed how to dispose of his enemies than how to make the most of his friends. This edition is illustrated by good wood engravings of many of the plants described, in great part from original drawings from the skillful pencil of Mr. Anthony Hochstein. A. G.

2. *Journal of the Proceedings of the Linnæan Society* (Botany), No. 10, (1858); contains:—

Synopsis of Legnotideæ, by George Bentham. He still regards these plants as forming a mere "tribe of *Rhizophoraceæ*," and as having "a general affinity with *Cunoniaceæ* and with *Lythraceæ*," as Brown long ago suggested. Mr. Bentham distinguishes nine genera, one of which is new, and about twenty-one species. One of the most interesting of these is a new *Crossostylis*, detected (in fruit only) by Prof. Harvey in the Feejee Islands, having fewer carpels in its gynæcium than Forster's *C. biflora*, for the elucidation of which we are indebted to the South Pacific Exploring Expedition under Capt. Wilkes. Mr. Bentham also contributes a

Notice of the Rediscovery of the genus Asteranthos, Desf., by Mr. Spruce.—Although ticketed as from Brazil, this curious plant was suspected to be African, because *Napoleona*, its only relative is African; but Spruce has now confirmed its American origin by finding it, in great abundance, upon the banks of one of the tributaries of the Casiquiare. Mr. Bentham inclines to Lindley's view of the close affinity of these two plants with the *Myrtaceæ*.

Monograph of the Eucalypti of Tropical Australia, with an arrangement, for the use of Colonists, according to the Structure of the Bark; by Dr. Ferdinand Müller, Government Botanist, Victoria.—The zealous and indefatigable Dr. Müller here describes 38 species in great part from the region which he had assisted to explore in Gregory's expedition. The succeeding popular arrangement by the bark divides them into six primary sections, the Latin characters of which will need translation before they can well be used by the colonists.

On some Tuberiform Vegetable Productions from China; by the Rev. M. J. Berkeley.—One of these *Fungi* (if such these apparently structureless rounded bodies are), the *Pu-foo-ling* of the Chinese, known immemorially in the northern part of China, where it is largely used as a drug and an esculent—and which was also described by Lourciro—proves to be identical with the *Tuckahoe* or Indian-bread of the Atlantic United States (*Lycoperdon solidum*, of Gronovius in Clayton's Flora Virginica, *Sclerotium Cocos* of Schweinitz, *S. giganteum* of Torrey, the *Pachyma Cocos* of Fries); thus adding another to the long list of species peculiar or nearly so to China or Japan and to the eastern side of North America.

Mr. Berkeley states that Tuckahoe has been analyzed by Prof. Ellet, and "ascertained to consist entirely of pure pectine of Braconnot. It is quite insoluble in water, though it dissolves in alkaline solutions, forming neutral pectates, whence the pectic acid is separated by the addition of muriatic acid, in the form of a colorless jelly: ..... This jelly may be prepared so as to form an agreeable article for the dessert."

We have not at hand the Gardener's Chronicle for 1848, referred to by Mr. Berkeley, in which the late Professor Ellet's account is probably cited. But we will at once reclaim the discovery and the original publication of these particulars for Professor Torrey, who, we may say, discovered that Tuckahoe was composed of pectine before pectine was itself discovered by Braconnot. Prof. Torrey's original paper upon the subject was read before the Lyceum of Natural History, New York, in the year 1819, and was published in the N. Y. Medical Repository for December, 1820; in this, after chemically ascertaining the properties of the substance, as since recognized, he adds that, "having shown that this principle differs from all those before described, it must be considered as a new species, and may be called *Sclerotin.*" In 1827, after the publication of Braconnot's paper upon pectic acid, Dr. Torrey republished his earlier paper, with some additions, in the New York Medical and Physical Journal (vol vi, No. 4), and showed the identity of the two substances. Moreover, he criticised,—it is still thought with good reason,—the characters assigned by Braconnot to pectic acid, being unable to detect any acid properties in the Tuckahoe itself, and attributing the acid reaction of the so-called pectic acid, as prepared, to some of the muriatic acid employed for coagulating the solution being entangled in the jelly so completely that it could not be removed by the most copious washing, even with alkali. And Braconnot's so-called salts of pectic acid were suspected to be mere mixtures of the sclerotin with the alkali employed to dissolve it, and entangled in the substance when the jelly was formed. Inasmuch as Prof. Torrey's experiments and publications were perfectly well known to the late Prof. Ellet, it seems probable that they were duly referred to in his own publication. If not, they certainly should have been.

Notes on Abuta, a genus of Menispermeæ; by Prof. Grisebach of Gottingen; correcting its characters and limitation, and reducing to it *Anelasma* of Miers.

Notes on Arctic Plants, by Prof. Dickie of Belfast.

No. 11, issued early in the present year, contains several articles; of which much the longest and most important is Dr. F. Müller's paper on *Australian Acaciæ*, with annotations by Mr. Bentham. A note on the *Morphology of the Balsaminaceæ*, by Prof. Henfrey, promises no small interest, but the present number closes with its mere commencement.

A. G.

3. Walpers, *Annales Bot. Systematicæ;* continued by Dr. C. Mueller.—Vol. IV, the first of the continuation, closes with the *Begoniaceæ*, —a full abstract of Klotzsch's well-known memoir. These details were the less needed, inasmuch as the order is now printing in DeCandolle's Prodromus. The first fasciculus of the fifth volume, issued at the close of the past year, carries on the work from the *Passifloreæ* to the Eupatorineous *Compositæ*. This is a very useful compilation, but not remarkably

well planned. The bare index to the 215 species of *Mesembryanthemum* figured by Salm-Dyck is contrived so as to occupy rather more than four pages. A. G.

4. *On Parthenogenesis;* by E. REGEL, (Bot. Zeitung, Oct. 8, 1858, and a translation by Henfrey in Ann. and Mag. Nat. Hist., Feb. 1859).—Mr. Regel stoutly denies vegetable parthenogenesis altogether; but some of his objections are those of a special pleader rather than of an investigator, such especially as his remarks upon the case of *Cœlebogyne.* He records, however, some new observations upon *Spinacia* and *Mercurialis*, upon female plants of which, after strongly cutting them in, he finds male flowers constantly developed, which without great care would have escaped notice; whence he concludes that the results obtained by Naudin and Decaisne are valueless. He thinks he might find imperfect anthers upon female plants of *Cœlebogyne!* It is to be hoped that he will have the opportunity of searching for them; also that the French botanists will repeat his experiments upon *Mercurialis*, &c. But how does Regel reach the conclusion if an embryo may in certain cases be developed when fecundation is prevented then stamens are wholly superfluous structures? As, on the one hand, there is considerable reason to suspect that hermaphrodite plants continuously self-fecundated would after a while become sterile and so verge to extinction, so, on the other, sexual fecundation may be strictly necessary to the perpetuation of the species, without being strictly indispensable for every generation. And if there really be parthenogenesis in plants (and the evidence still seems to show that there is), then it is not likely to be restricted to two or three special cases, nor to diœcious species; but it is probable that some of the seeds in ordinary fruits, especially in polyspermous ones, are sometimes perfected without fecundation. *Natura non facit saltum.* A. G.

5. *Notices sur l'Amelioration des Plantes par le Semis, et Considerations sur l'Hérédité dans les Vegetaux*, &c.; par M. LOUIS VILMORIN. Paris, 1859, 8vo pamphl., pp. 64.—This very interesting pamphlet is a collection and reprint of several of Louis Vilmorin's important communications to the Central Agricultural Society of France and to the Academy of Sciences; to which is prefixed a French translation of a memoir upon the Amelioration of the Wild Carrot, contributed by his venerable father to the Transactions of the London Horticultural Society (but not before published in the vernacular of the author), which memoir, as the younger Vilmorin informs us, was the point of departure for his own investigations in this field, and even contains the germ of most of the ideas which he has since developed upon the theory of the amelioration of plants from the seed. These papers claim the attention of the philosophical naturalist, no less than of the practical horticulturist.

Most of our esculent plants are deviations from the natural state of the species, which have arisen under the care and labor of man in very early times. New varieties of these cultivated races are originated almost every year, indeed; but between these particular varieties, the differences, however well marked, are not to be compared for importance with those changes which the wild plant has generally undergone, in assuming the esculent state. In this amelioration or alteration, as in other cases, *c'est la premiere pas que coûte.* For the altered race, once origin-

ated, has much less stability than the wild stock; it accordingly tends, not only to *degenerate* (as the cultivator would term it) towards its original and less useful state, but also to *sport* into new deviations, in various directions, with a freedom and facility not manifested by its wild ancestors. This explains the readiness with which we continually obtain new varieties of those esculent plants which have been a long time in cultivation, while a newly-introduced plant exhibits little flexibility. To detect the earliest indications of sporting, and to select for the parents of the new race those individuals which begin to vary in the requisite direction, is the part of the scientific cultivator. In this way, the elder Vilmorin succeeded in producing the esculent carrot from the wild stock in the course of three generations,—no addition to our resources, indeed, but significant of what may be done by art directed by science. By adopting and skillfully applying these principles, the younger Vilmorin has conferred a benefit upon France which (if she will continue to make sugar from the beet) may almost be compared with that of causing two blades of grass to grow where only one grew before, having, so to say, *created* a race of beets containing twice as much sugar as their ancestors, and indicated the practicability of its perpetuation. The mode of procedure, and the ingenious methods he contrived for rapidly selecting the most saccharine out of a whole crop of beets, as seed-bearers for the next season, are detailed in these papers.

Once originated, and established by selection and segregation for a few generations, the race becomes fixed and perpetuable in cultivation, with proper care against intermixture, in virtue of the most fundamental of organic laws, viz., that the offspring shall inherit the characteristics of the parent,—of which law that of the general permanence of species is one of the consequences. The desideratum in the production of a race is, how to initiate the deviation. The divellent force, or idiosyncracy, the source of that "infinite variety in unity which characterizes the works of the Creator,"—though ever active in all organisms, is commonly limited in its practical results to the production of those slighter differences which ensure that no two descendants of the same parent shall be just alike, being overborne by that opposite or centripetal force, whatever it be, of which ensures the particular resemblance of offspring to parents. Now the latter force, as Mr. Louis Vilmorin has well remarked, is really an aggregation of forces, composed of the individual attraction of a series of ancestors, which we may regard as the attraction of the type of the species, and which we perceive is generally all-powerful. There is also the attraction or influence of the immediate parent, less powerful than the aggregate of the ancestry, but more close, which ever tends to impress upon the offspring all the parental peculiarities. So, when the parent has no salient individual characteristics, both the longer and the shorter lines of force are parallel, and combine to produce the same result. But whenever the immediate parent deviates from the type its influence upon its offspring is no longer parallel with that of the ancestry; so the tendency of the offspring to vary no longer radiates around the type of the species as its centre, but around some point upon the line which represents the amount of its deviation from the type. Left to themselves, as Mr. Vilmorin proceeds to remark, such varieties mostly perish in the vast

number of individuals which annually disappear,—or else, we may add, are obliterated in the next generation through cross-fertilization by pollen of the surrounding individuals of the typical sort,—whence results the general fixity of species in Nature. But under man's protecting care they are preserved and multiplied, perhaps still further modified, and the better sorts fixed by selection and segregation.

Keeping these principles in view, Mr. Vilmorin concluded that, in order to obtain varieties of any particular sort, his first endeavor should be to elicit variation in any direction whatever; that is, he selected his seed simply from those individuals which differed most from the type of the species, however unlike the state it was desired to originate. Repeating this in the second, third and the succeeding generations, the resulting plants were found to have a tendency to vary widely, as was anticipated; being loosed, as it were, from the ancestral influence, which no longer acted upon a straight and continuous line, but upon one broken and interrupted by the opposing action of the immediate parents and grand parents. Thus confused, as it were, by the contrariety of its inherited tendencies, it is the more free to sport in various ways; and we have only to select those variations which manifest the qualities desired, as the progenitors of the new race, and to develope and fix the product by selection upon the same principle continued for several generations.

It is in this way that Mr. Vilmorin supposes cross-fertilization to operate in the production of new varieties; and even in the crossing of two distinct species, the result, he thinks, is rarely, if ever, the production of a fertile hybrid, but of an offspring which, thus powerfully impressed by the strange fertilization, and rendered productive by the pollen of its own female parent, is then most likely to give origin to a new race.

We cannot follow out this interesting but rather recondite subject in a brief article like this. But we are naturally led to enquire whether the history of those plants with which man has had most to do, and the study of the laws which regulate the production and perpetuation of domesticated races, may not throw some light upon the production of varieties in Nature; and whether races may not have naturally originated, occasionally, under circumstances equivalent to artificial selection and segregation. Some recent attempts which have been made in this direction we may hope to notice upon another occasion. A. G.

6. *Botanical Necrology for* 1858.—The list of botanists who have departed during the past year is a long one, and includes some most eminent names,—such as those of Brown and Bonpland, which have already been noticed in the pages of this Journal. The following are the principal:—

Dr. B. Biasoletto, of Trieste; died January 17, 1858, aet. 65. He was a local botanist of merit, and an investigator of the *Algæ* of the Adriatic.

Aimé Bonpland, the well-known companion of Humboldt in American travel, and ever since a resident of Paraguay. Died in the 85th year of his age, August 22, 1857, but his decease was not announced in Europe until after the close of that year.

Robert Brown, of London, long since styled by Humboldt *Botanicorum facile princeps:* died May 10, 1858, in the 85th year of his age.

Prof. G. A. Eisengrein, of Freiburg in Briesgan; died July 26, 1858.

H. Galeotti; a scientific traveller and well-known botanical collector in Mexico and Central America; died in April, aet. 44.

W. T. Gumbel, of Landau, Rhenish Bavaria; a distinguished bryologist, associated with Schimper in the publication of the later portions of the *Bryologia Europœa:* died Feb. 10, 1858, aet. 46.

Mrs. Loudon, the widow of *J. C. Loudon*, herself an able popular writer of works upon gardening and botany, and a person of remarkable ability, whose name may well claim a place in this list: died, near London, in July, 1858.

Prof. Ernest H. F. Meyer, of Königsberg: died, August 7, at a mature age. His earliest work, a monograph of *Juncus*, was published in 1819.

Prof. C. F. A. Morren, of Louvain, died, Dec. 17, 1858; aet. 52. His writings mainly relate to physiological matters.

Dr. J. B. Mougeot, of Bruyères, in Eastern France, a cryptogamist of considerable note: died, Dec. 5, 1858, aet. 82 years.

Prof. C. G. Nees von Esenbeck, long one of the most distinguished and productive botanists of Germany, and for almost half a century President of the old Imperial Society Naturæ Curiosorum: died March 16; aet. 82 years.

David Townsend, of West Chester, Pennsylvania, the life-long associate of the venerable Dr. Darlington, who has published an interesting memorial of his friend and companion in botanical pursuits. Dr. Darlington and Mr. Townsend have made the quiet borough of West Chester famous in botanical annals, and have set an example worthy of all imitation. Although not, like his distinguished associate, a botanical author, Mr. Townsend was an excellent and active local botanist, and was so skillful and tasteful in the preparation of dried specimens that Sir William Hooker associated his name with that of Professor Short of Kentucky, as preëminent in this important art. Mr. Townsend's name is commemorated in the genus *Townsendia*, of Hooker, peculiar to North America, now comprising six of seven species of humble but beautiful, Aster-like plants. The botanist whose name they will perpetuate died, Dec. 6, 1858, at the age of 71 years.

Dawson Turner, Esq., of Yarmouth, one of the oldest of British botanists, who so early as the year 1802 published his first work upon the British Fuci, died on the 20th of June, 1858, at the age of 83 years.

C. Zeyher, whose name with that of Ecklon, is so intimately associated with the botany of the Cape of Good Hope, which he has so extensively explored, died at the Cape, near the close of the past year.

A. G.

7. *Mammoth Tree of California—Sequoia gigantea.* (From an article by Dr. B. Seemann, Ann. Mag. Nat. Hist., [3], iii, 175).—The mammoth tree was introduced into European gardens by Mr. William Lobb; and in 1853 single plants were sold by Veitch's Nursery for £2 2*s*.; but since then quantities of seeds have been imported, and there is now hardly a horticultural establishment without one or more representatives of this remarkable evergreen. In England it seems to stand the winter without injury; and even in Germany and other parts of Northern Europe it does not require the protection of a glass house; so that even

in those countries it may become a forest- and useful timber-tree. In July 1856, complaints were heard that, in spite of the most careful culture, a peculiar disease had befallen this new *Sequoia*, in consequence of which the twigs were observed to die off in the same manner as they do in *Cryptomeria Japonica.* Horticulturists began to take alarm, and feared that their new acquisition would inevitably be lost; but Dr. Lindley soon discovered that, though the twigs died, the main stem and branches continued to grow vigorously, and that the so-called disease was constitutional, and could not be looked upon as a sign of ill-health, or a proof of bad culture. In 1858 it bore ripe fruit in England, under the skillful treatment of Mr. J. Buckle, at Thetford.

8. *Prodromus Descriptionis Animalium Evertebratorum, etc.* Invertebrates collected during the North Pacific Expedition under Captains Ringgold and Rodgers, U. S. N., and described by W. Stimpson. Part VII.—Mr. Stimpson, in this paper, published in the Proceedings of the Academy of Natural Sciences of Philadelphia (Dec. 1858), continues his catalogue, notes and description of species of Crustacea from the North Pacific expedition. The number of species brought home by Mr. Stimpson was very large, and the new species alone exceed six hundred. Part VII contains the Anomoura. The collections in this tribe number 83 species; and with the help of extensive collections of the described species, he has been enabled to give the subject a careful revision. In the Dromia tribe he has instituted the new genera *Dromidia* (for *Dromia hirsutissima*, Lamk.), *Cryptodromia* (for *Dromia nodipes*, Lamk.), *Pseudodromia*, *Petalomera*, *Conchoecetes* (for *Cancer artificiosa* Herbst). The large genus *Porcellana* he has subdivided, apparently on good grounds, as follows:

A. *Antennarum externarum articulus primus brevis, marginem carapacis superiorem non attingens.*

Petrolisthes, nov. gen. Carapax depressus, subovatus, non latior quam longior; fronte triangulari, margine plus minusve undulata, dentata vel integra. Oculi sat grandes. Antennarum pedunculus plus minusve cristatus. Chelipedes lati, depressi. Pedum ambulatoriorum dactyli normales, i. e. breves, sat robusti, unguiculo unico.—*Typus*, P. violaceus. *Porcellana violacea*, Guerin; Mag. de Zool., 1838, p. 5, pl. xxv, f. 2. *P. macrocheles*, Pœppig.—Chili.

Pisosoma, nov. gen. Carapax rotundatus, sat convexus, non longior quam latior. Frons superne visa recta, integra. Chelipedes crassi. Dactyli pedum ambulatoriorum normales.—*Typus*, P. pisum. *Porcellana pisum*, M. Edw.; Hist. Nat. des Crust. ii. 254.—Mari Orientali.

B. *Antennarum externarum articulus primus plus minusve productus et margini carapacis junctus; articulus secundus orbitâ remotus.*

Raphidopus, nov. gen. Carapax rotundatus, latior quam longior. Frons non prominens, fere recta, tridentata. Oculi minuti. Pedum ambulatoriorum dactyli longi, recti, gracillimi compressi et acutissimi.—*Typus*, R. ciliatus, infra.

Pachycheles, nov. gen. Carapax rotundato-ovatus, non longior quam latior; epimeris postice solutis, parte posteriore quadrata, interstitio cutaneo disjuncta. Frons medio parum prominens, subacuta. Antennarum articulus primus minus productus. Chelipedes crassissimi, rugosi; carpo brevi. Pedum ambulatoriorum dactyli normales.—*Typus*, P. grossimanus. *Porcellana grossimana*, Guerin; Mag. de Zool. 1838, pl. xxvi, f. 3.—Chili.

Megalobrachium, nov. gen. Carapax rotundatus, non longior quam latior. Frons augusta, laminata, parum prominens, fere recta. Oculi minuti. Chelipedes crassi, mero magno, manu brevi. Pedum amb. dactyli normales.—*Typus*, M. granuliferum, Stm.—Ins. Antillarum.

PORCELLANA, Lam'k, restrictum. Carapax plerumque longior quam latior, lateribus carinatus; epimeris integris. Frons sat lata, prominens, plus minusve dentata. Orbitæ profundæ. Antennarum articulus primus valde productus, intus acutus. Chelipedes sat depressi; carpo brevi, margine anteriore intus sæpius unilobato; digitis sæpius contortis. Pedum amb. dactyli normales, sat longi. *Typus*, P. platycheles, Lam'k; An. s. vert., v. 230.—Europa.

MINYOCERUS, nov. gen. Carapax angustus. Frons tridentata. Antennulæ longiores, articulo primo magno depresso, dentato. Antennarum articulus primus ei *Porcellanæ* similis; pars mobilis minuta, qnadriarticulata, quam art. primus non longior. Chelipedes debiles. Pedum amb. dactyli normales.—*Typus*, M. angustus. *Porcellana angusta*, Dana; loc. cit. i. 423, pl. xxvi, f. 12.—Brasilia.

PORCELLANELLA, White. (Voy. Rattlesnake, ii. 394.) Carapax oblongus, multo longior quam latior, lateribus fere parallelis; lobulus gastricis obsoletis. Frons horizontalis, laminiformis, valde prominens, tridentata. Antennæ ei *Porcellanæ* similes. Chelipedes læves, carpo brevi, manu elongata. Pedes ambulatorii parvi, mero crasso, dactylis brevibus, uncinatis, compressis, multi-unguiculatis.—*Typus*, P. triloba, White; l. c., ii. 394. pl. v, f. 2.

POLYONYX, nov. gen. Carapax rotundato-ovalis, latior quam longior, convexus, lævis. Frons sat angusta, recta. Antennularum articulus primus non dentigerus. Antennarum articulus primus prælongus. Oculi minuti. Chelipedes læves; mero magno. Pedum amb. dactyli brevissimi, lati, intus bi- vel multi-unguiculati. *Megalobrachio* affinis, dactylis exceptis.—*Typus*, P. macrocheles. *Porcellana macrocheles*, Gibbes; Proc. Am. Assoc. 1850, p. 191.—Carolina.

A list of all known species pertaining to each of these proposed genera is added, after much careful study of specimens.

Under the Hippidæ there is the new genus *Mastigopus*, and under Albunidæ, *Lepidopa*. Among the Lithodea, the *Lithodes hystrix* of De Haan is referred to the new genus *Acantholithus*. Among the Paguridea, there are the new genera *Petrochirus* (for the *Pagurus granulatus* Oliv., M. Edw.), *Isocheles* (for the *Bernhardus æquimanus* Dana), and *Spiropagurus* (for the *Pagurus spiriger* De Haan).

9. *Memoires pour servir a l'Histoire Naturelle du Mexique, des Antilles et des États-Unis;* par HENRI DE SAUSSURE. Première livraison, *Crustacés nouveaux du Mexique et des Antilles.* 4to pamph. pp. 80 and 6 plates. Geneva, 1858.—The materials for this work were collected by the author himself during his visit to America. The Mexican Crustacea are all from the eastern or Gulf shores. There are in all fifty-six species described, forty-nine of which are believed by the author to be new. Besides these, as is stated in the preface, several probably new species were collected, about which the author could not be certain, for want of access to books and collections;—a want certainly unfortunate, as it seems to have caused M. de Saussure to fall into some errors regarding what he did venture to publish. At the present day it will be found highly desirable for those writing upon subjects connected with American zoology, to consult the works of American naturalists. In the case before us for instance, a knowledge of the carcinological writings of Say and Gibbes would have enabled the author to have rendered his work more accurate, and saved him some labor.

In the preface Mr. de Saussure gives some interesting general remarks, including details confirmatory of the principle first pointed out by Prof. Dana,—that Crustacea attain their maximum of development in the temperate, and not as with other Articulates, in the tropical zone. He is in error, however, in asserting that the "langouste" (*Palinurus*) inhabits the latitude of Philadelphia and New York.

The diagnoses of most of the species were published in the *Revue Zoologique* for the year 1857. In that journal two new genera were described; *Pseudotelphusa*, which Mr. de Saussure now considers identical with *Potamia* (*Boscia*); and *Halopsyche*, referred to Gebiens, which is now acknowledged to be *Alpheus*. In fact *Halopsyche luturia* is closely allied if not identical with *Alpheus heterochelis* of Say. In describing new species it is always a great aid to their subsequent recognition, to mention those forms to which they most approximate in character, and if closely allied, to indicate the differences. But the author even when describing species apparently identical with previously described ones well known in this country, neglects to make such comparisons.

We should scarcely have ventured upon the following criticisms were it not for the excellent figures which adorn the work, and enable us to recognise several of the species with considerable certainty. The author has failed to apply some of the recent improvements in the science, neither De Haan's subdivision of *Lupa* nor Dana's of *Pagurus* being adopted, while more doubtful Parisian novelties of classification, as in *Grapsus*, are fully recognised. *Pericera bicornis* De S., seems to be very near to *P. bicorna* (Edw.) Gibbes; if distinct it should certainly receive a more diverse name. *Lambrus crenulatus* is interesting as being the first species found on the American shores, of a genus so abundantly represented on those of the old world. *Chlorodius americanus* seems to be one of the numerous varieties of *C. floridanus* Gibbes. Three new species of *Panopeus* are described, *P. occidentalis*, *serratus*, and *americanus*, from Guadeloupe, all closely allied to *P. Herbstii*, (with which they should have been compared,) but apparently distinct. We have specimens of *P. serratus* from Florida. The genus *Portunus* is new to our waters; the author describes one species, *P. guadulpensis* (guadelupensis ?). The three species referred to Milne Edwards' genus *Metopograpsus* will not probably fall into that group; at any rate *M. dubius* De S., is identical with *Pachygrapsus transversus* Gibbes, a common West Indian species, and the other two species seem to be closely allied, and also referable to *Pachygrapsus*. In the *Metopograpsi*, an East Indian and Pacific group, the internal suborbital lobe is joined to the front. *Plagusia gracilis* appears to be a good species, differing from *P. Sayi* in the quadrilobate margin of its epistome. *Hepatus tuberculatus* De S. should be compared with the young of *H. decorus*. *Remipes cubensis* is a good species, characterized by the marginal band of lineolæ uninterrupted by a longitudinal sulcus. We had almost simultaneously indicated this species as *R. barbadensis*, it being the *Squilla barbadensis ovalis* of Petiver. *Pagurus cubensis* De S. is probably *Clibanarius sclopetarius*, as the characters agree except in one point;—it is said of the feet that "La première paire atteint un peu au delà du milieu du troisième article de la deuxième paire." We presume however that the author means the third of those joints which project from beneath the carapax. *Caridina mexicana* would be more properly referred to *Atyoida*, for in *Caridina* the second pair of feet have a long slender carpus not bifurcated at the extremity. (See M. Edwards; Hist. Nat. des Crust., pl. 25bis, f. 4.) Seven new *Palemons* are described, which we should have judged to be freshwater species, but our author says that they, as well as *P. jamaicensis*

are found on the coasts. Of Tetradecapoda twelve species are described,—one *Amphitoe*, seven *Porcellios*, one *Armadillo*, one *Pseudarmadillo*, (a new genus between *Armadillo* and *Armadillidium*,) one *Anilocra*, and one *Cymothoa*. The only Entomostracan is *Chlamydotheca azteca*, of a new generic type forming a subdivision of the old genus *Cypris*.

W. S.

10. *Observations on the Genus Unio*; by Isaac Lea, LL.D.—In our notice of Dr. Lea's Memoir we stated that the embryonic form of the shell in the case of 38 species of Unionidæ is figured without details on one of the plates. We intended to say without details on the plates. There are detailed descriptions occupying eight pages of the memoir.

11. *Catalogue of the Described Coleoptera of the United States*; by Friedrich Ernst Melsheimer, M.D., revised by S. S. Haldeman and J. LeConte. 174 pp. 8vo.

12. *Catalogue of the described Diptera of North America*; prepared for the Smithsonian Institution by R. Osten Sacken. 92 pp. 8vo.

These two works were issued the past year by the Smithsonian Institution. They are of great value to all interested in these departments of Entomology.

IV. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *Appendix to the Article on Fluctuations of the Water Level of the Lakes* (p. 305); by C. Whittlesey. (Received too late for insertion in connection with the article.)—Since this article was written I have seen the following notices of the discovery of a lunar tide on Lake Michigan, by gentlemen who have made observations at Milwaukee and at Chicago.

"It may not be improper for me to add, that very numerous observations have been made here to ascertain the character of the fluctuations of the level of Lake Michigan, one of the results of which was announced by me in the Milwaukee Daily Sentinel & Gazette, of Sept. 3d, 1849, in the following words:

'*An Important question settled.*—By a series of observations made every three hours during the month of August, 1849, I have ascertained that there *is a slight lunar tide on Lake Michigan.*'

Other subsequent observations made *hourly both day and night*, for two months, fully confirmed this conclusion. I. A. Lapham.

Milwaukee, Dec. 24th, 1858."

At a meeting of the Chicago Historical Society, Nov. 30th, 1858, I find among the proceedings the following report:

"An interesting announcement was made at this meeting by Lieut. Col. J. D. Graham, U. S. A., of the recent discovery of the operation of lunar attraction upon the waters of Lake Michigan.

A series of accurate tidal observations has, during the last four years, been prosecuted under the superintendence of Col. Graham, resulting in the discovery above noticed. The supposed influence is more noticeable at the period of the moon's conjunction or opposition, and in tranquil weather, the observed extent of it being about two-tenths of a foot.

The brief announcement by Col. Graham will, it is hoped, be followed by a detailed statement of facts and data at a future day."

2. *Report on the History and Progress of the American Coast Survey up to the year* 1858, by the Committee of twenty appointed by the American Association for the Advancement of Science at the Montreal meeting, August, 1857. 88 pp., 8vo.—The committee of twenty appointed by the Association, consisted of Judge J. K. Kane, Pres. Amer. Phil. Soc. Pa., Gen. J. G. Totten, Chief Engineer U. S. A., Prof. Benjamin Peirce, Harvard College, Mass., Prof. John Torrey, U. S. Assay Office, N. Y., Prof. Joseph Henry, Sec. Smithsonian Institution, D. C., Prof. J. F. Frazer, University of Pennsylvania, Pa., Prof. Wm. Chauvenet, U. S. Naval Academy, Md., Pres. F. A. P. Barnard, University of Mississippi, Miss., Prof. John Leconte, College of South Carolina, S. C., Prof. Wm. M. Gillespie, Union College, N. Y., Prof. F. H. Smith, University of Virginia, Va., Prof. W. H. C. Bartlett, U. S. Military Academy, N. Y., Prof. Wolcott Gibbs, Free Academy, N. Y., Prof. Stephen Alexander, College of New Jersey, N. J., Prof. Lewis R. Gibbes, Charleston College, S. C., Prof. Joseph Winlock, Sup. Am. Alm., Ky., Prof. James Phillips, University of North Carolina, N. C., Prof. Wm. Ferrel, Nashville, Tenn., Prof. Edward Hitchcock, Amherst College, Mass., Prof. James D. Dana, Yale College, Conn. After the death of Judge Kane in February, 1858, Pres. F. A. P. Barnard was appointed chairman of the committee.

The Report treats of the methods of coast survey in different countries, the history of the Coast Survey in this country, the results up to 1858, and the benefits to navigation, commerce, and general science. We have presented in a recent article a review of some of these results. This Report gives a broader and fuller exposition of the whole subject, and exhibits in a strong light the indebtedness of the country to the ability and excellent management of Prof. Bache, the Superintendent. It is only necessary to cite here from the concluding pages of the Report the recapitulation of the conclusions concurred in by "the Committee with entire unanimity."

"1. The American Coast Survey, in its inception, was a work imperatively demanded by a due regard to the industrial interests of the country, dependent, as they are, greatly upon the prosperity of commerce for their free development.

2. The indecision which marked the early policy of the government in regard to this Survey, and the consequent delay of its efficient operations, and postponement of its beneficial results, were of manifest disadvantage to the material welfare of our people, and cannot but be still subjects of serious regret.

3. The economical value of such surveys is attested by the universal voice of all commercial men, and by the concurrent practice of all commercial nations, no less than by the melancholy records of marine disaster annually occurring upon every unexplored coast.

4. Their scientific value is witnessed, in the instance of the American survey, by the spontaneous tributes of approval frequently and freely bestowed upon it—no less in regard to the ability, energy and skill displayed in its management, than to the magnitude, variety, and oftentimes curious interest of the results it has wrought out—by individuals and organized bodies of men, whose high position as scientific authorities renders their opinions upon subjects of this nature entirely conclusive.

5 This work has conferred many valuable benefits upon science, indirectly and incidentally, in the invention or perfection of instruments, in the improvement of methods of observation or of computation, in the development it has given to special subjects of interesting inquiry, and in the stimulus which it has furnished to the scientific talent of the country, especially in the field of astronomical observation and investigation.

6. A careful study of the progress made from year to year, especially since the enlargement of the scale of operations under the present superintendent, affords ample evidence that the work has been expeditiously prosecuted, and the amount accomplished up to the present date is materially greater than has ever been accomplished in any other country in the same length of time, and with the same means.

7. Compared with the same surveys executed or in progress of execution by foreign governments, the American survey has been conducted with remarkable economy.

8. Compared with such foreign surveys, the quality of the work done in this will bear the test of any standard that has ever been anywhere set up, and is such as to reflect honor on the scientific character of our country in the eyes of the world.

9. Every consideration of economy, of humanity, and of regard for the reputation of the country, demands that the work should be prosecuted with undiminished activity, until every portion of our coast shall have been as thoroughly explored and mapped as those have been already in which its operations commenced.

10. Conclusive reasons, involving other weighty public interests no less than this, but connected also with the project of verifying in the happiest manner the geodesy of our extended and circuitous coast, conspire to render the triangulation of the great Appalachian chain of mountains a most desirable undertaking, and encourage the hope that our government will very early direct that most important work to be executed.

11. The publication in full of all the observations upon which the published results of the Coast Survey are founded, together with the methods employed in the reduction and discussion of the observations, would be a contribution to science, and especially to the science of geodesy, of inappreciable value, besides being necessary to secure the records against loss; and the committee earnestly hope that the government may not fail to provide the means for the adequate and rapid prosecution of the work.

12. The existing organization of the Survey, judged in the light of the experience acquired by our own and by foreign governments in the management of such works, is, in the deliberate opinion of the committee, preferable to any other that has ever been suggested."

3. *Note on the Height of the Atmosphere.*—A letter from Mons. Emm. Liais published in the *Comptes Rendus* (Jan. 10, 1859, p. 109) gives the results of his inquiries into the height of the atmosphere as deduced from observations on polarization made at the tropics at the commencement of dawn and the end of twilight. The letter is dated San Domingos, Bay of Rio Janeiro, Dec. 6, 1858. His observations at that place, Dec. 1, 2, and 3, indicated that the limit of atmospheric polarization was 0^m 40^s in passing from 20 degrees east of the zenith to 20 degrees west. But at San Domingo, of which the latitude is 23° S., the limit of the

shadow passes over 25·6 kilometres per minute, or 247·5 kilometres in 9^m 40^s. From this the height of the atmosphere is calculated to be 340 kilometres or 211 miles.

4. *Museum of Comparative Zoology at Cambridge.*—Since our last (see pp. 295–299 this vol.) a new and most encouraging aspect has come over this important movement. The legislature of Massachusetts, after listening to the persuasive eloquence of Agassiz, exhibiting in the most catholic and unselfish spirit the claim of the subject upon the public purse, has appropriated one hundred thousand dollars for a zoological museum, on the condition that as much more should be subscribed, including the legacy of Mr. Francis C. Gray of $50,000, for the same purpose. The subscription soon amounted to $80,000 besides this legacy, or in all, including the bounty of the State, to the magnificent sum of $230,000 (*two hundred and thirty thousand dollars*). It is now proposed to make up the whole amount to a quarter of a million.

It will be remembered that the legacy of Mr. Gray is for the expenses of the museum exclusive of salaries or buildings.

This bounty of the State is derived from the sales of a large tract of land in the city of Boston reclaimed by the commonwealth from the "*Back Bay*," and hence called the "*Back Bay lands.*" The whole proceeds of this noble domain so far as by partition with the city and the contractors they belong to the State (and they are estimated by millions) are solemnly dedicated to the cause of education—ever held most sacred in great-hearted Massachusetts. Were it pertinent to our pages we should delight to transfer to them all that relates to this subject, but we will content ourselves by giving the act of incorporation for the "*Museum of Comparative Zoology*, passed April 6, 1859."

"An act to incorparate the Trustees of the Museum of Comparative Zoology:

Be it enacted by the Senate and House of Representatives in General Court assembled, and by the authority of the same, as follows:

Section 1. The Governor, the Lieutenant Governor, the President of the Senate, the Speaker of the House of Representatives, the Secretary of the Board of Education, the Chief Justice of the highest Judicial Court, *ex officiis*, and Louis Agassiz and William Gray, together with Jacob Bigelow, James Walker, George Ticknor, Nathaniel Thayer, Samuel Hooper, Samuel G. Ward and James Lawrence, and their successors, are hereby made a body politic and corporate, by the name of the 'Trustees of the Museum of Comparative Zoology,' with all the powers and privileges set forth in the Forty-fourth Chapter of the Revised Statutes, so far as the same are applicable to the purpose for which said Corporation is established, as hereinafter mentioned, and not inconsistent with the provisions of this Act.

Section 2. Said Corporation may receive, hold, purchase and possess real and personal property not exceeding three hundred thousand dollars in value, to be used and improved for the erection, support and maintenance of a Museum of Comparative Zoology at Cambridge, in this Commonwealth; and the sum of fifty thousand dollars, heretofore contributed in aid of the Museum of Comparative Zoology by William Gray, shall be deemed to be a part of the sum required to be raised by private subscription for the said Museum, as a condition precedent to the payment by the Commonwealth to said Trustees of any part of the avails of the sales of land in the Back Bay.

Section 3. The places of Louis Agassiz and William Gray, whenever the same or either of them shall become vacant by death, resignation or otherwise, shall be filled by a concurrent vote of the Senate and House of Representatives, and the

same course shall be afterwards adopted when the place of the successor of either of them shall become vacant; but any vacancy occasioned by the death, resignation or otherwise, of any of the other persons named in this Act (except the members designated *ex-officiis*), or of the successors of such persons, shall be filled by election by the whole board of Trustees, at meetings specially called for that purpose.

SECTION 4. The said Trustees shall arrange, so far as may be done consistently with the interests of the institution, for the distribution of duplicate specimens, by exchange or otherwise, among other colleges and institutions of learning in this Commonwealth and elsewhere. And the Museum belonging to said Trustees shall, at all reasonable times, and under reasonable regulations, be kept open to the public free of charge.

SECTION 5. This act shall take effect from and after its passage."

5. *Conservatory of Art and Science.*—By force of that "perpetual semination" which Lord Bacon says is ever the surest sign of a great principle, Agassiz's example has awakened, it seems, in the whole body politic in Massachusetts a noble zeal to secure for the citizens of the whole State a truly National Museum, on the broad plan of the British Museum, or rather, it is said, to unite the features of the Paris Garden of Plants with the *Conservatoire des Arts et Metiers*, to be located at Boston and endowed and sustained by the public purse. This movement promises to be successful as soon as a proper plan is matured. The Committee on Education commended it to the legislature in the strongest manner, and only certain considerations of a private nature between the City of Boston and the Commonwealth prevented its taking the form of law a month ago. The source of endowment is to be also the Back Bay lands. The spirit of Boston and its commonwealth is adequate not merely to conceiving, but to giving practical efficiency to any plan for a great public museum which the wisdom of its citizens may elaborate; for there, is ever found the happy union of the designing mind and the executive hand—the ability both to *say* and to *pay*.

6. *Legacy to Yale College, New Haven.*—The bequest of the Hon. Henry L. Ellsworth to Yale College, amounting, it is estimated, to two or three hundred thousand dollars, is appropriated by the will to scholarships, and is therefore rather a gift to the public than to the College itself. The will is to be contested and the issue is doubtful. If sustained, the College will receive from it only tuition fees, and these, as is well known, meet but little more than half the expenses of instruction. It is a munificent donation to the general interests of public education.

7. *Journal of the American Geographical and Statistical Society.*—The American Geographical and Statistical Society of New York has commenced the publication of a monthly Journal of thirty-two large octavo pages. The enterprise is important and deserving of hearty encouragement. We wish it complete success.

The object of the Journal, as stated in the introduction, is to furnish information on Geographical and Statistical subjects, by the publication, in a form adapted to their preservation and convenient use, of the papers read before it, and of communications with which it may be favored; to cultivate and cherish a taste for research in the wide field of Geography and Statistics; and to create among its members an interest that will secure their hearty co-operation in the promotion of its objects. In the absence, both in the Federal and State Governments, of bureaus specially devoted to these subjects, a work similar in character to the one now presented seems indispensable to their proper elucidation and publication.

OBITUARY.—Prof. WILLIAM W. MATHER, acting President of the University of Ohio at Columbus, died in that city, February 26, 1859. He was graduated at the U. S. Military Academy in 1828—where he continued to reside as instructor in mineralogy and geology, and assistant to the professor of chemistry until 1834–5. In 1836 he resigned his commission in the army and devoted himself exclusively to scientific pursuits. Being appointed by the Governor of New York one of the four principal geologists for the survey of that state, his final report on the geology of the first district was published in a large quarto in 1843. This was his most important original work—and it will always bear honorable testimony to his ability and accuracy as an observer in this department of nature. He held the post of geologist to the state of Ohio from 1837 to 1840, and published three annual reports of which notice will be found in the first series of this Journal. He was also for a time charged with a geological reconnoissance of the state of Kentucky and published one preliminary report on that state. Since 1842 he has been connected as an instructor with the University of Ohio. His contributions to the pages of this Journal have been numerous and important both in chemistry, mineralogy and geology. His paper, entitled "Contributions to Chemical Science," printed in vol. XXVII, first series (1835), gives ample evidence of his ability in practical chemistry. His age is not reported; but he could not have been far from fifty-five years. He was a native of Middlesex county, Connecticut.

Proceedings of the American Association for the Advancement of Science. 12th meeting, held at Baltimore, May, 1858. 320 pp. 8vo. Cambridge, J. Lovering.

United States Exploring Expedition, during the years 1838, 1839, 1840, 1841, 1842, under the command of C. Wilkes, U.S.N.—Mammalogy and Ornithology. By J. Cassin. 4to. VIII, 466 pp. With a Folio Atlas of 53 plates. *Philadelphia*, 1858.

W. BUCKLAND: Geology and Mineralogy considered with reference to Natural Theology. New edit., with Additions by Owen, Phillips, Rb. Brown, and Memoir of the Author. Edited by Fr. T. Buckland. 2 vols. *London*, 1858. 8°. 760 pp.

JOURN. ACAD. NAT. SCI. PHILAD., Vol. VI, Part I.—96 pages 4to, with 20 plates.

PROCEEDINGS ACAD. NAT. SCI. PHILAD. 1859.—p. 1, Note on some tribes of Western Africa; *P. B. Duchaillu.*—p. 3, New species of Pomotis; *Morris.*—Fossil Fishes of the Carboniferous of Kansas; *J. Leidy.*—p. 4, New species of Tortoises; *J. Le-Conte*—p. 8, Geol. Expl. in Kansas; *Meek* and *Hayden* (this vol. p. 424).—p. 30, Birds of Western Africa; *J. Cassin.*—p. 56, Ichthyological Notices; *C. Girard.*—p. 69, Catalogue of the Coleoptera of Fort Tejon, California; *J. L. LeConte.*

PROCEEDINGS BOSTON SOC. NAT. HIST. Vol. VI.—p. 400, Description of some Insects; *S. S. Haldeman.*—p. 404, Note on parasites of Orthagoriscus mola (Sun-Fish); *J. C. White.*—p. 407, Notes on Fishes; *Agassiz.*—p. 409, Decomposition of sesquioxyd of chromium, by caustic alkali; *C. T. Carney.*—p. 410, On the forms of Birds; *T. Lyman.*—p. 411, On the Discoboli; *Agassiz.*—New genus of Crustacea between Pinnotheres and Hymenosoma, called Hapalocarcinus; *W. Stimpson.*—p. 414, Note on temperature of ocean limiting the geographical distribution of species; *Agassiz.*—p. 416, Report on Dr. I. I. Hayes's proposed expedition to the North Pole.—p. 418, On the N. A. species of Mustela; *Kneeland.*—p. 418, On European species of Salmo found in America; *Agassiz.*—p. 422, Land Shells of the N. Pacific Expedition; *A. A. Gould.*—p. 426, On the mechanism of the flight of Lepidoptera; *Agassiz.*—p. 428, Stephanurus dentatus of Diesing; *J. C. White.*—p. 428, On the breathing apparatus of Menobranchus; *Kneeland.*

Vol. VII. March, 1859.—p. 1, On the power of larves of eating flesh poisoned by arsenic; *F. H. Storer.*—p. 3, Notes on some Fishes; *Putnam.*—p. 5, Birds of East Florida.

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